IMPROVING CUSTOMER SATISFACTION IN TRANSPORTATION DECISION MAKING

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IMPROVING CUSTOMER SATISFACTION IN

TRANSPORTATION DECSION MAKING

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SUMMARY

Transportation decision makers are tasked with doing more improvements with less funding, which requires effective tools to assess and predict the outcomes of their choices. The objectives of this research are to explore customer satisfaction in various contexts, assess its application in transportation contexts and develop quantitative, empirically-based tools that improve customer satisfaction in transportation decision making. This research conducted a survey of targeted customer satisfaction practitioners and their planning products and tested the implicit assumption.

The findings are significant and contrary to current theory and practice. The results support the hypothesis that the impact of negative performance is different than the impact of positive performance on customer satisfaction in a transportation context. These findings suggest that the relationship is asymmetrical and nonlinear contrary to implicit assumptions of current decision support tools like the Importance-Performance Analysis (IPA) matrix. The results also identify that transportation agencies identify quality of life and customer satisfaction as an important goal and measure for their regions. These results suggest that customer satisfaction is a tool in decision making and there is an empirical methodology to accurately assess the relationship of performance to satisfaction that can impact resource decisions in transportation. The results also suggest that customer satisfaction can be used to address issues of social equity and the broader goals of transportation plans.

CHAPTER 1

INTRODUCTION

The current economic downturn has caused many public agencies to rethink their decision making paradigms in order to provide the most bang for their dwindling bucks. In transportation this economic squeeze is felt even more strongly because the operation and maintenance of the existing system is not extinguishable and the costs of repair to the aging infrastructure are increasing. Even in strong economic times, solid decision making based upon measurable and predictable benefits and accurate costs is desirable. There is never enough funding to complete all of the desired programs so effective decision making is a key element of effective system management.

In transportation, resource decision making occurs in the planning process. This process is a mixture of public input, technical assessment and political evaluation which yields a selection of policies, projects, and programs that meet the vision of the future. The mix of perspectives in the process can often cause turbulence and discord (Kelly, 2005; Bonsall, 2005; McFadden, 2007). In addition to its nature, the role of the planning process has expanded over time. The goals of transportation plans now include the social, environmental, health and educational impacts of transportation. These goals are not readily addressed by traditional transportation analysis methods. The objective of this research is a tool that can accommodate the broader goals and provide a transparent justification for varying perspectives.

It is proposed that customer satisfaction is a tool that can accommodate these objectives. Customer satisfaction is an intuitive measure that a wide range of audiences can easily grasp without specialized education. Satisfaction is a cognitive action that balances the object and subjective elements of an experience (Oliver 1980). It also incorporates the public's, who are transportation service customers, perspective. If an empirical analytic approach can be developed it has the potential to address the broader goals of transportation services. Customer satisfaction as a transportation tool may be a means to improve decision making for transparency, justification of resources and addressing the broader goals that are not accounted for in traditional analysis.

Customer satisfaction is a well known and well developed concept in private sector business development and service industry research. Leveraging the research from product-based industry and adapting it to the transportation context could yield valuable insights into the use of customer satisfaction as a decision making tool.

Two major concepts from the product-based literature are relevant to this effort, 1) the expectancy disconfirmation model (Oliver 1980) and 2) the asymmetrical nonlinear relationship (Anderson, 2000; Matzler, 2004). These concepts will be detailed in later chapters but the impact to customer satisfaction in transportation decision making is considerable. First the expectancy disconfirmation model, diagrams the interaction of perceived performance, expectation of performance and customer satisfaction. This model makes use of data already prevalent in transportation contexts. Second, the asymmetrical nonlinear relationship found in product-based research states that the relationship of performance to satisfaction is not necessarily linear; meaning for every dollar spent on improving performance there may not be an equal improvement in satisfaction. Currently, in most transportation decision making contexts there is an implicit assumption that the relationship is linear. This research tests that assumption which impacts practice through many transportation decision support tools (Stradling 2007; Cantalupo 2002).

Collecting customer data via surveys is a common practice for most public agencies however that data is often used only for public relations and marketing campaigns. These efforts are valuable to an agency but the data collected could also be used to inform the planning process in the form of customer satisfaction data. The current survey design do not collect all of the required information but the effort and resources are already allocated to this task thus, adding or modifying the data collected could be an incremental cost that provides a monumental benefit.

The objectives of this research are to determine if customer satisfaction information can be used in an empirical analytic tool and if so, how it can be incorporated into the transportation planning process for aid in decision making. This research investigates the relationship of customers' perception of satisfaction and its elements, and how those measures can be integrated into the transportation decision making process.

The context of this research is exploratory, meaning not much is known about the problem at the outset. Developing insights and refining the gaps in knowledge is an objective of this research. This exploration of customer satisfaction in transportation decision making can lead to more effective design of future research and conclusive results. This dissertation combines theoretical concepts and practical applications to add value to the transportation decision making process. The research looks at a broad range of literature for theoretical evidence of customer satisfaction in an empirical analysis and for innovative practices in other industries.

This dissertation is laid out in six chapters. The first chapter introduces the research topic and explains the objectives, context and scope. Chapter 2 provides an extensive review of the literature in three parts. The first part examines the literature in a transportation context to determine the state of the practice, the second part investigates the literature in transportation planning to frame the process in which this research will be applied and the last part looks at customer satisfaction in non transportation sources. This part provides definitions and models of customer satisfaction in product based industry and public administration.

Chapter 3 is a presentation of the proposed customer satisfaction framework. This framework is developed by using the output of the research tasks. The framework suggests how customer satisfaction can be incorporated into the existing transportation decision making paradigm and what benefits and challenges to expect in each stage of the application.

Chapter 4 is the methodology for each of the research tasks. Chapter 5 lists the results of those research tasks. Task 1 is a targeted practitioner survey, where customer satisfaction innovator agencies were contacted to determine the type of data collected, how it was used and by what departments. This was done to ascertain the formalization and standardization of the customer satisfaction practices per agency. Task 2 is a practitioner document review, where each of the targeted practitioner agencies' long range plans was reviewed to determine if customer satisfaction is institutionalized and congruency with customer satisfaction practices. Task 3 is a test of the asymmetrical nonlinear assumption concept to test the hypothesis that the impact of high performance differs from the impact of low performance on satisfaction which would indicate a nonlinear relationship. If this concept holds true the methodology used can serve as a basis for the empirical analysis of customer satisfaction data in a transportation decision making process.

Chapter 5 is a discussion of the results and the research to further refine the research topic of customer satisfaction as a decision making tool and provide recommendations for further investigation. Lastly, Chapter 6 offers some conclusions about the contributions, significance and impact of this research and future research efforts to expand the body of knowledge.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

This chapter describes the varied research pools canvassed in order to characterize the current thinking of customer satisfaction in transportation decision making. This topic requires a broad reach into disparate fields from marketing, public administration, product-based operations, planning and programming for multiple modes and industries. The organization of this chapter begins with a literature map of how the various research pools are integrated to answer certain questions of the literature; next a background of customer satisfaction in transportation context including transit and auto modes. Then an explanation of the transportation planning process from the perspective of customer satisfaction follows; next customer satisfaction in non-transportation literature is examined including a review of specific product-based customer satisfaction studies. The chapter concludes with a synthesis of the literature and identification of gaps in the knowledge of customer satisfaction in transportation decision making to frame the research problem.

2.1.1 Research Pools

This research bridges several research pools to define the gaps in knowledge and application. For this reason widely disparate industry research was investigated for relevance to the topic. Even though the initial research pools are disparate, a common thread within each pool begins to converge and support the current research. A visual representation of the process of integrating research findings, their overlapping themes and hierarchical relationship are shown on the literature map (Figure 2.1). Some of the key literature from each of the fields is listed in italics below the topic area of where it is most influential

In many cases the scholarly publications, journal articles, and research reports apply to multiple topical areas. For instance, Silkunas 1993 is listed in the Transit literature research pool in Figure 2.1 because his research lens is in the context of transit viability in the 20th century; however, his perspective and recommendations integrate product based industry approaches to transit applications. This is important to the organization of this research because recurring themes and key concepts appear in various research pools and are the basis for the structure of the research hypothesis.

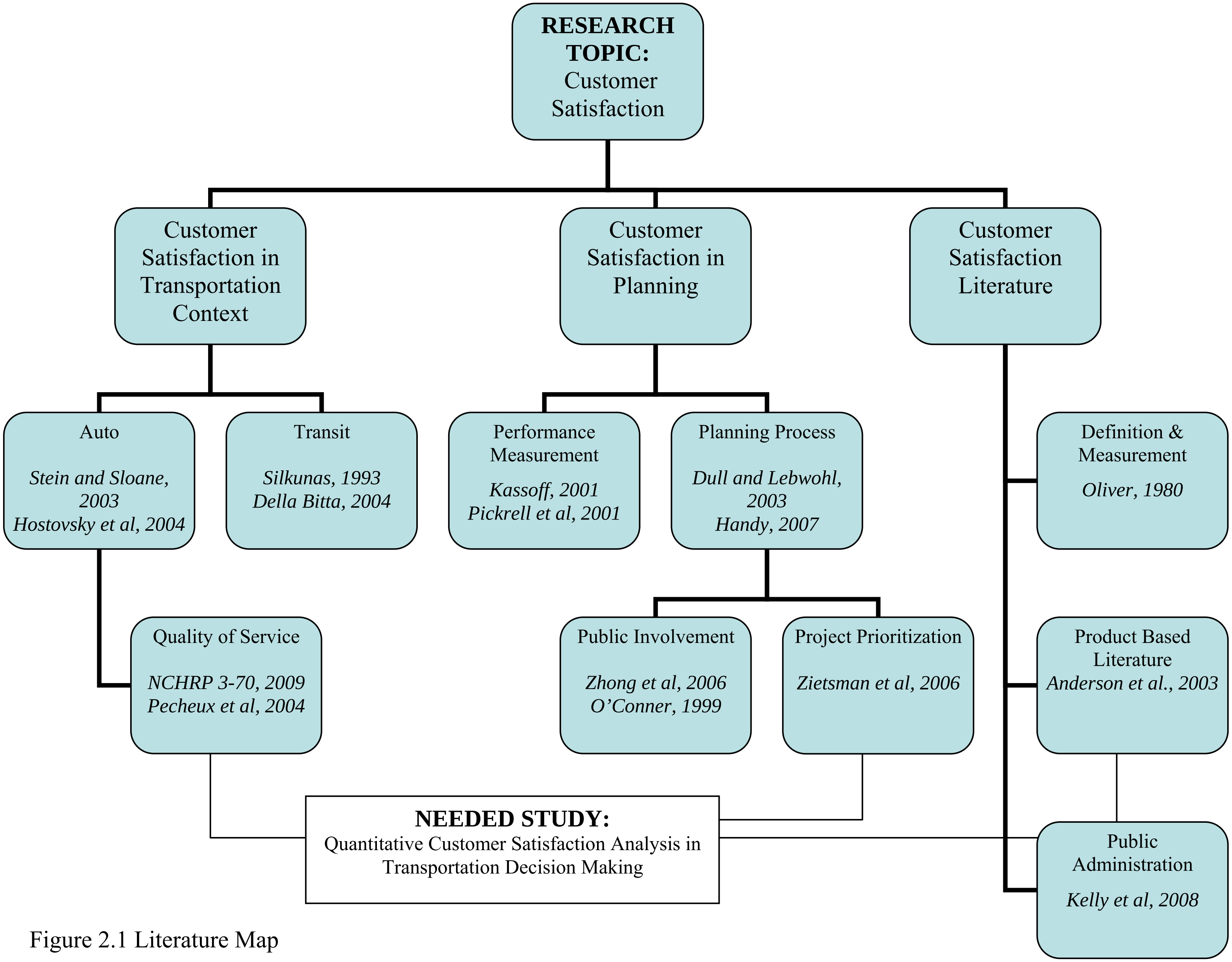

Figure 2.1 Literature Map

2.1.2 Literature Questions

The publications and research fields were selected for their ability to answer fundamental questions about the topic. Table 2.1 lists the six principal questions the literature was intended to answer and which, or what combination of, research pools address the question.

Table 2.1 Questions of the Literature

1	***What is Customer satisfaction?*** Product-Based Literature Performance Measurement Literature Customer Satisfaction Definition & Measurement Literature
2	***Can Customer satisfaction be used in empirical analysis?*** Product-Based Literature Customer Satisfaction Definition & Measurement Literature
3	***What research has been done in Customer satisfaction?*** Transportation Literature - Auto Product-Based Literature Transit Literature Quality of Service Literature Customer Satisfaction Definition & Measurement Literature
4	***How is Customer satisfaction currently used in transportation context?*** Transportation Literature - Auto Public Involvement Literature Planning Literature Project Prioritization Literature
5	***How can Customer satisfaction be used in transportation context?*** Product-Based Literature Project Prioritization Literature Quality of Service Literature Customer Satisfaction Definition & Measurement Literature
6	***What is the best way to measure Customer satisfaction?*** Public Involvement Literature Performance Measurement Literature Customer Satisfaction Definition & Measurement Literature

Table 2.1 illustrates that many of the disparate pools combine to answer the research questions.

2.2 Customer Satisfaction in Transportation Context

2.2.1 Introduction

This section describes the background of current transportation customer satisfaction practices. How it is defined and measured, survey design and data analysis methods, as well as the applications, usage, and integration with decision making of current and emerging customer satisfaction research for multiple modes in a transportation context.

2.2.2 Background

Since the 1970s, transportation authorities have become more engaged with the public in terms of public meetings, marketing campaigns, stakeholder involvement and educational programs to inform and empower the transportation customer (O'Connor, 1999). This is partially due to litigation over engineering methods of alternatives analysis and the public's demand for a transparent government decision-making process. An outcome of this era in transportation policy was that the customer perspective and ultimately their satisfaction have been elevated as a valued measure of the service provider's performance (O'Connor, 1999).

There is evidence that customer focused initiatives are expanding into other areas of transportation services as well. In 1992, the National Quality Initiative (NQI) was formed by federal and state agencies and industry to promote quality transportation systems primarily by measuring the performance of critical infrastructure elements (Tuggle, 1994). This concept has grown to include measurement of key practices and objectives of an agency. With an aging transportation infrastructure public agencies are shifting focus from building to maintaining their systems and the efficient use of resources to maximize performance.

Including customer satisfaction as a performance measure for investment decisions shows a culture shift in transportation as a service industry rather than strictly production. Some researchers find that customer satisfaction also has greater potential for application by a wider range of agencies and organizations (Cantalupo, 2002). Even with their limitations many government agencies have conducted extensive customer surveys to rate how well they are meeting expectations and what customers think of their products and services. These surveys are often used as part of public relations campaigns but the satisfaction rating is not integrated into the decision making process or as a tool for prioritizing projects.

2.2.2.1 Definition and Measurement

Customer satisfaction measurement is inherently lagged and the understanding of its relationship to projects is limited. This is in part due to the evaluative nature of customer satisfaction. Most of the existing research is on improving current input flows of the transportation planning process (Stein, 2003). The current project selection process is not designed for qualitative input like customer satisfaction (Handy, 2008) and public involvement efforts have traditionally been front-end only (O’Connor, 1999).

Most transportation agencies collect customer information but customer satisfaction is a specific type of customer information. The primary difference is what data is collected and how it is analyzed. One transportation researcher finds that "Customer satisfaction is measured by a change in the user's perceptions of the adequacy of service provided according to the mode utilized" (Cantalupo, 2002). So it is possible that customer satisfaction is also defined by the way it is measured. However, Stradling et al, define satisfaction in their 2007 study as involving metrication of both customer perceptions and expectation of service (Stradling, 2007). The inclusion of expectation is a fundamental element of satisfaction development (Oliver, 1980) in product based models. However, in transportation contexts the expectation of performance is not commonly collected.

Defining the customer is also a debatable point for surface transportation practices (Stein, 2003). Focused segmentation practices emerging in data collection efforts are vital to defining the customer (VKCRC, 2002). However, this segmentation is often determined by transportation agency objectives and directives not by customer behavior (Kelly, 2005). McFadden (2007), concedes that transportation is affected by human behavior through its consumers, managers, policy makers and voters. And that by having this human interaction transportation decision models would benefit from a better understanding of the human role (McFadden, 2007). Also Bonsall (2005), finds that the importance, quality and priority of service attributes vary among transportation professionals and the public. This finding is echoed in Zhong (2006), Kelly (2005), UTIP (2002), and Kelly (2002), which suggest that segmentation based upon customer behavior may prove more valuable to understanding customer satisfaction than strictly using professional judgment.

Accurate and meaningful segmentation is not only helpful it is vital according to a Hostovsky study (Hostovsky, 2004). The perception of service was shown to be dependent upon the segment of freeway users queried including importance and performance ratings. Rural, urban and commercial segments had significantly divergent priorities not supported by objective performance variance for the segments. This means that the objective value of a performance attribute had less to do with the users' perception of performance than their driving environment, or segmentation.

2.2.3 Customer Satisfaction for Auto Mode

Customer satisfaction for auto mode has traditionally been focused on improving customer ratings of service performance external to the decision making process (Stein, 2003). There is a rich history of collecting customer information in the form of surveys and more recently through public involvement and outreach efforts. This section discusses the processes and outcomes of various customer satisfaction efforts for auto mode programs.

2.2.3.1 Surveys

Collecting and reporting customer data by use of surveys, public meetings and the internet (Bilotto, 2003) is a common practice for State DOTs, MPOs, localities and transit agencies. In many cases this is the only opportunity the public has to let their officials know what they think of the choices that have been made on their behalf, other than the voting booth. Surveys are commonplace for collecting "dashboard" type information (Poister, 2002) but using that data to affect resource allocation and project selection is limited.

Typical survey design is reliant on stated preference. Missouri DOT for example, included expectation of performance attributes but still did not include trade-offs between attributes to elicit relative importance (Pigg, 2004).The stated preference approach is limited because a stated preference often differs from an actual preference at the time of decision. However there are pioneering agencies diversifying their data collection efforts to include importance, performance and overall satisfaction for specific service attributes (Cantalupo, 2002). The expansion of survey design can lead to better analysis methods to determine the impacts of qualitative data and broader quality of life objectives.

Additionally, many state agencies do not have in-house expertise to design, implement or analyze the Customer satisfaction data so they are dependent on qualified consultants to provide this service. Planning for the expense and time to conduct the surveys is an important aspect to address when considering integrating Customer satisfaction into infrastructure decision making process.

2.2.3.2 Sample Data Findings

This section discusses the findings from five customer satisfaction data collection efforts from four sample states to show a cross-section of data collection and analysis methods typical of current customer satisfaction practices. The sample states are Florida (Stutzman, 2003), Missouri (Pigg, 2004), Kentucky (Anderson, 1997 and Langley, 2004), and Louisiana (McKenzie, 2004). The data discussed in this section are represented in

Appendix A. The five states compared used surveys to collect their customer data. Telephone surveys were the predominant choice but a combination of mail and telephone were used in the Florida project. Although the type of data collection was consistent across the board the methods varied. Many of the call lists were generated by random digit dialing techniques which are intended to produce a random sample. This method proved difficult for Florida's resident survey because a large percentage (48%) of the numbers were non-household. Kentucky (Langley, 2004) and Louisiana addressed this issue by using list assisted random digit generation. Other surveys with more targeted respondents, like the professional drivers in Kentucky's 1997 effort (Langley, 2004), were chosen from a list of prospective respondents with those specific characteristics (i.e. a list of CDL holders).

Most of the states made an effort to recruit a sample size of statistical significance and representative of their state's demographics. However some were unable to accomplish this task and devised alternate methods to achieve their goal. For example, Missouri used an equally distributed number of respondents per DOT district which did not replicate the population distribution, so they applied weighting factors to the results (Pigg, 2004). The development of the survey instrument was contracted out in all of the comparison states. However, Florida and Missouri involved stakeholders during the development of the survey with Florida conducting focus groups to ascertain the interest areas for their segmented survey approach. This method of segmentation is echoed in the Virchow Krause report for Wisconsin DOT, (VKCRC, 2002) as a value to addressing specific customer issues.

The surveys format was either a four or five point scale from extremely/totally satisfied to extremely/totally dissatisfied. One quite unique divergence is Louisiana's survey which used a letter grade scale A-F. In Louisiana's approach any grade above D was included in the 'satisfied' rating.

The primary form of analysis for the sample states was a simple frequency analysis. Some states used specialized statistical programs for the analysis. The results were stratified both geographically and by socioeconomic factors (age, VMT, number of years driving in state). However this type of analysis does not give decision makers much evidence of how their policies are affecting the customers' perspective now and in the future (TCRP report 47, 1999). Missouri used a gap analysis approach where the identified interest areas were rated based on expectation and perceived performance. The difference between them is the gap index which is used in an Importance Performance Analysis (IPA) decision matrix to define which interest areas are failing and of concern. This method accounts for the importance of an attribute and identifies the relative satisfaction.

Other models that could be used for customer satisfaction analysis are regression analysis and factor analysis. Regression analysis models could be used to interpret the relationship between a specific individual attribute and the overall satisfaction rating. A factor analysis model is helpful in categorizing the data into information units used to identify potential underlying components of the satisfaction rating (Pigg, 2004). These models are much more labor intensive and require expertise that may not be available or expensive to gain.

Each state's approach was unique and relevant to their uses. However, it is difficult to compare results across the country because of the diversity in customer satisfaction practices. It is important to note that the use of the data is largely within a state boundary so this multi-state diversity may be a minor issue, however three of the five comparison states included questions in their survey relating to their performance with respect to other or neighboring states. This interest in benchmarking against other states may lead to the development of cross-jurisdictional measures.

2.2.3.3 Sample Data Integration

Many agencies using customer satisfaction data do not have a formal integration policy, but it is likely that they use the data in an ad hoc fashion to address customer perspectives. However this does not provide the benefit of a transparent decision making process for the customer. Some of the barriers to integration with infrastructure decision making are the types of questions asked and the generality of results. The frequency of a rating does not address the underlying cause of its failing or exceeding expectations. Another barrier is the results are not distributed widely or understood by decision makers.

In Florida (Stutzman, 2003) and Louisiana (McKenzie, 2004) the statewide strategic plan has specific objectives intended to improve customer satisfaction and the image and credibility of their agency. While this linkage to their strategic plan is encouraging, it does not identify how the measures would be used to make decisions. The opportunity to provide feedback in the data collection stage is helpful, at the disaggregate level, for identifying reasons for the rating and addressing the customer's desire to be heard. But it does not directly relate to any of the transportation planning and prioritization processes.

PennDOT revamped their customer feedback system to be more actionable; using a performance ‘report card’ distributed to districts which would then be incorporated into their business plan for maintenance service quality (Poister, 2002). The Delaware model (Cantalupo, 2002) establishes a link to the state’s long range plan through a performance monitoring program and thus resource allocation by programming funds to address customer satisfaction deficiencies. Another implication of goal setting prior to the survey activity is the consensus building within an agency regarding the use of the data (Pigg, 2004); it can also assist in designing an instrument that yields the intended information.

Some of the challenges to integration of customer satisfaction measures into the infrastructure investment decision-making process are the lack of regulation or standard approach for using customer satisfaction data: the design, implementation and analysis are largely diverse. Also the nature of customer perspectives does not neatly fall into the organizational structure divisions of an agency, so there are many varied interests and potential uses of the data. And lastly, it is an ongoing process which requires a long-term view of transportation and future needs of the system.

2.2.4 Customer Satisfaction for Transit Mode

Much of the transportation customer satisfaction literature comes from the transit mode. Particularly because transit has a “closed” system they can count users and changes in usage that results from policy initiatives (UITP 2002; TCRP Report 47, 1999). Also, transit has been a pioneer because of the pay-at-service nature of the transit service.

However, they have limited influence or effect on the roadways system that they share with other modes (UITP, 2002). Their power in addressing customer's needs in this regard (for instance travel time reduction) is minimal. However the methods and rationale used for functions within their control allow for a base understanding of how auto-mode based customer satisfaction programs can collect, analyze and use customer information.

Transit experiences in customer satisfaction are much more robust. Transit agencies are able to objectively measure the impacts of their policies, improvements and projects which is a difficulty for surface transportation; even though there is objective data available on usage it is not as readily apparent what the alternatives are for roadway customers.

The primary objective of various transit customer satisfaction programs is to increase ridership, by improving the services' customers value (Guziak, 2002). Transit agencies extensively survey their customer's opinions on current performance, future services and value of services (Stein 2003, Della Bitta 2004, Stuart 2000, Guziak 2002, Spitz 2004). The research indicates that a mix of objective and subjective measures as well as pre-filled and open ended questions on surveys leads to the most useful data to manage their services (Stein, 2003; Spitz, 2004). The use of incentives like lowered fares or passes help reduce attrition rates throughout a panel survey. A similar incentive based panel survey may prove valuable to collecting the relevant customer satisfaction data for surface transportation applications.

Additionally, the analysis methods transit agencies use to model their performance and predict future satisfaction are far more advanced than surface transportation applications. For example, New York City transit utilized a structural equation model of customer satisfaction (Stuart 2000, Stuart 2002) to test policy initiatives prior to application. This approach used panel data from a revolving segment of riders who had been customers since 1995. This approach allowed the transit agency to predict customer opinion before resources were committed, and integrate customers' opinions that were collected as part of the panel project into the decision making process. Also, the Center for Urban Transportation Research's (CUTR) comparative analysis for South Miami-Dade Busway and Lynx LYMMO in Florida (Baltes, 2003) utilized a derived importance approach. Unlike typical surveys that collect ratings of importance, the CUTR project used stepwise regression to derive the overall importance of each of the service attributes under investigation, and determine its relative importance.

The Transit Cooperative Research Program (TCRP) developed a customer satisfaction and service quality handbook in 1999, intended to standardize the approach transit agencies used to measure customer satisfaction and service quality (TCRP Report 47, 1999). The University of Rhode Island utilized the approach designated in the TCRP report for the Rhode Island Public Transit Authority to identify service attributes that are most closely linked to satisfaction and to pilot the approach from the report. The Rhode Island pilot found that some of the basic assumptions of the approach needed to be refined, specifically that gap scores, an element of the impact score, are stable over time (Della Bitta, 2004). The gap scores are the absolute value difference between mean satisfaction score of riders who did not experience problems and the mean satisfaction score of riders who did experience problems. The TCRP approach uses the basic model that service attributes lead to a rider evaluation, which contributes to the level of global satisfaction, which in turn leads to endorsements, repeat purchase behavior, etc. This model mirrors the basic model found in product-based literature.

Beyond the service attributes transit customer satisfaction also includes the transit worker as an important element of transit customer satisfaction. This personal element is unique to the transit mode because many of the service elements are actually provided by a human contact.

2.2.5 Quality of Service

The Quality of Service (QoS) literature is moving in the direction of quantifying customers perceived level of performance and its determinate attributes, relating these to traditional Level of Service (LOS) categories. Flannery finds that there are several objective attributes of perceived service that influence customers' ratings (Flannery, 2006; Pecheaux, 2004), such as presence of exclusive left-turn lane, average lane width, and number of stops. These attributes can be observed and show correlation to the mean service level ratings. Some of these factors are traditionally outside of the transportation realm like aesthetics, presence of trees, etc. However, these findings are important in developing a systematic approach to understanding the customer's perspective and perceptions of their transportation experience. Additionally, from a policy perspective, determinate attributes of customer satisfaction that are not traffic related are also important to the formation of policies, incentives and programs since their scope is often broader than singularly transportation design. The service industry literature states that determinant service attributes are determinants of satisfaction (Della Bitta, 2004) and there are multiple determinant factors to customer satisfaction. Identifying the attributes of customer satisfaction can lead to analytical methods to predict customer satisfaction, founded in the way customers develop their perceptions of satisfaction not limited to traditional engineering design measures. The QOS research is not limited to auto drivers; transit and bicyclist perceptions are also a part of the research for urban street design.

2.2.6 Summary of Customer Satisfaction in Transportation Context

The main points of this section are that transportation agencies want tools to address customer perspectives because there has been a culture shift to a more service oriented approach. Transportation agencies are incorporating customer satisfaction by including it as a performance measure in performance monitoring systems and through other uses of their customer data, like maintenance management systems. However customer satisfaction is not formally integrated into decision making. Customer surveys are commonplace in the transportation context but customer satisfaction is a specific type of customer information that is not common in current survey design. Primarily the expectation of performance is missing from current survey data, which limits the analysis tools and interpretation available to transportation professionals. Also, current surveys collect information comparing neighboring states but without a standardized approach this is not a meaningful comparison.

Two other survey design points of concern are that the definition of customer is not standard and that decision makers' priorities differ from the publics'. However careful segmentation based on customer priorities and behavior can help address the customer definition issue. This expansion and extension of the survey design and analysis requires expertise that is not common, cheap or quick.

Lessons can be learned from transit's experience in customer satisfaction. The 'closed' system, pay-per-service environment of transit allows measurement of impacts of policy decisions on customer's satisfaction. Transit uses more sophisticated analysis tools to predict customer satisfaction. They also have a standardized formal approach toward customer satisfaction and quality measurement. The transit agencies use incentive based panel studies to collect extensive data.

The Quality of Service research is an emerging field intended to incorporate customer perceptions into transportation design. This research has discovered objective and subjective influential determinates of customer satisfaction. Some of these determinate attributes are outside of the traditional transportation design purview but may still prove useful for decision making. These attributes are the building blocks of analytical methods to predict customer satisfaction in the transportation context, for auto mode.

2.3 Customer Satisfaction in Transportation Planning

2.3.1 Introduction

The transportation planning process is where most of the resource decision making occurs. Additionally, the planning phase includes visioning, defining what needs to be and will be measured, as well as incorporating public opinion on directives developed by the agency and matching priorities with funds. The current transportation planning process is in flux due to the broadening of planning goals and the overlapping impacts of transportation to other aspects of modern life (health, education, social welfare, etc) (Ross, 2007). Developing tools to address these broader goals is a major ongoing effort in this field. Bertolini et al, sum the current state of urban transportation succinctly in their 2008 Transport Policy editorial:

> "The defining feature(s) of the emerging urban transportation planning discipline is: 1) that the discipline is in the midst of a paradigmatic transition, 2) transportation planning has an overarching aim: enhancing the quality of life and 3) the importance of collaboration, integration and exchange with other professions and policy sectors"

This section will discuss how customer satisfaction is included in the traditional planning process, how it informs decision makers and affects policy decisions, as well as the need for and efforts to create improved tools to address the broader goals. Taking special note of how customer satisfaction fits into the transitioning process. This section details three steps of the process: public involvement, project selection and prioritization, and performance measurement as a step of the planning process and as a field unto itself, to identify challenges and opportunities for incorporation of customer satisfaction measures in the transportation planning process.

2.3.2 The Transportation Planning Process

The planning process as identified in Figure 2.2, is the basis of the plan development process used by Metropolitan Planning Organizations (MPOs) and State Departments of Transportation (DOTs). The figure depicts the cyclical nature of the transportation project development process. The transportation planning process itself is very complex with many trade-offs and iterations, the description that follows is therefore an idealized process as if all steps were self contained, independent and linear. It is adapted from the Urban Transportation Planning text by Meyer and Miller (Meyer, 2001).

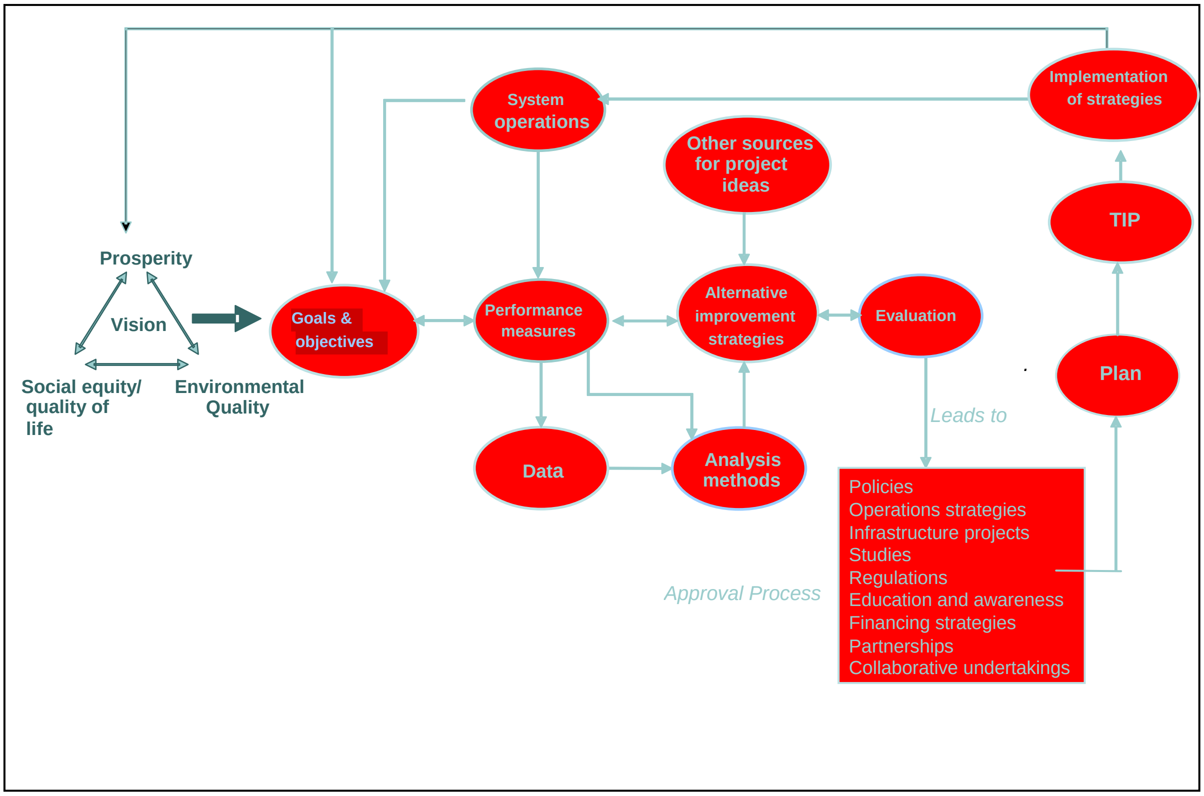

Figure 2.2 Transportation Planning Process (from Meyer and Miller, 2001)

The process begins with a vision; the vision is influenced by the prosperity, current and future, social and environmental issues of the region/analysis area. Often citizens and stakeholder groups are involved in the visioning process to incorporate the customers' desire for their region. The next step is to objectify the vision of the region, matching goals and objectives to the citizens and stakeholders abstract view of the future. Developing performance measures for the goals and objectives follows, this step allows for agencies to determine how they will measure their attainment of the goals set in the previous step. A vital aspect of good performance measurement is that there is data available or collectable and that there are analytic methods that can use the available data to determine the performance of selected attributes, services, or policies. The performance measures should also incorporate findings from previous or existing projects, services and policies as encountered through system operations. Developing alternative improvement strategies (construction projects, policies, regulations, etc) are based upon the desired performance levels, determined in the previous step, intended to address the needs of the region. Utilizing other project sources like stakeholders and partner agencies as well as mandates can also provide input to designing alternative strategies. The next step then compares the various improvement strategies and evaluates the estimated system improvement of each. The outcome of this step is how well the strategy addresses the vision, goals and objectives of the region as determined by how much improvement to the performance measures. This is called a “tiered” system (Cantalupo, 2002) where the performance measures correspond to the goals, strategies and actions of the plan. The output of the evaluation step are a grouping of strategies (projects, policies, regulations, etc.) that are matched to the funds available and set into motion as the Regional Transportation Plan (Plan) and the Transportation Improvement Plan (TIP) depending on the timeframe being considered. Once dollars are attached the strategy is implemented and operated. Information gathered from the implementation and system operation then informs the performance measurement determination for the next planning cycle.

From a decision making perspective, the planning process is split into technical and political phases. The steps leading to evaluation are technical, with the exception of visioning and goal setting. Those two elements are largely public involvement directed (Zhong, 2006), however once the goals have been set the technical staff determines how the public opinion is to be measured and implemented. Once the technical elements have been determined and a list of strategies are generated the politics of the process are central to the outcome of selection (Pickrell, 2001). At times the technical recommendations can be less significant than the political implications of selection. This is a necessary part of the process because decision makers represent the public at large and they must accept the total package of strategies put forward in the transportation plans, that it addresses their constituents' needs, and desires.

As mentioned previously, transportation goals and recognition of their impacts are broadening to include environment, health, education, equity, quality of life and social inclusion issues which require institutional integration within and among all levels of government (Hatzopoulou, 2008). Likewise current analysis methods are being retooled to align with the changes occurring in the transportation planning process. The traditional travel forecast tool, the four step travel demand model, produces forecasts for a limited set of measures, which is a significant constraint (Handy, 2008).

2.3.2.1 Public Involvement

The public involvement step is typically how the planning process gets customer buy in (O'Connor, 1999), either for direction or agreement with the direction determined by the transportation agency. The term public involvement is often used to describe the mandated environmental alternatives analysis step in major project implementation before an Environmental Impact Statement (EIS) or Record of Decision (ROD) can be approved by the governing agencies.

However, public involvement has grown to mean any activity undertaken by an agency to generate public input (CPIT, 1999). Good public involvement should be distinguishable from public relations and public information efforts by its incorporation of citizen input into decision making (O'Connor, 1999). Some of the characteristics of effective public involvement are: 1- Inclusive participation, internally and externally, 2- Serious and timely input of public input, 3- Devolution/redistribution of decision making power, 4- Transparent process, 5- Two-way communication, 6- Use of technology, 7 – Methods to maintain public's interest (Zhong, 2006).

To wit most public involvement activities occur during project development phases not planning phases (Hatzopoulou, 2008), where the difference is the scope of the development process. Project development as used here, refers to a specific project of determined scope i.e., widen state route X. Whereas planning phases refers to the regional program development, for example ease congestion on State Route X, the latter could have many possible projects, create alternative truck route, widen the route or even operational improvements. The most common planning phase public involvement efforts are related to citizen committees that inform the Plan development process.

However, transportation agencies are in almost constant contact with the traveling public through, marketing and public awareness campaigns, surveys of service performance and complaints. This customer information is largely missing from the decision making processes. With new technologies available in transportation planning more avenues to collect customer information are emerging (Zhong, 2006). Additionally, there are efforts underway to standardize and assess the effectiveness of the public involvement process (CPIT, 1999).

There is no debate that the customer's satisfaction is important but how to collect, measure, analyze or use it in decision making is not clearly identified. Additionally, it can be difficult to keep the public's interest in broad sweeping initiatives or for prolonged periods of time (Hatzopoulou, 2008; O'Connor, 1999).

2.3.2.2 Project Selection and Prioritization

The project selection and prioritization phase is a tradeoffs analysis of various alternatives, combined with fiscal constraints. If there are 100 M dollars worth of worthy strategies but only 50 M dollars to spend how do decision makers decide which strategies to fund? This process is often more political than technical with legal issues of equitable spending and air quality attainment among others (Zeitsman, 2006; Pickrell, 2001). For this reason this phase is not very transparent or clearly codified in any research. However, the ultimate goal of any project selection and prioritization effort is to get the most effective grouping of strategies that further the vision of the region.

Cost Benefit Analysis (CBA) strategies are commonly used for project prioritization and selection. This process forecasts benefits as determined from travel demand models and the actual costs of implementing the strategy. This type of analysis tends to favor urban areas and roadway projects (deSilva, 1996; Johnson, 2008) because the criteria used to measure benefits are often congestion based. In urban areas the improvement impacts are disseminated to a larger population which increases the magnitude of the forecast benefit. Because of this bias, the Houston-Galveston MPO technical advisory committee uses categories of improvements to develop benefit criteria. Categorizing projects for prioritization create a better modal mix of projects in their plan (Johnson 2008). Another researcher in western Australia found that using value-for-money techniques reduced the bias toward urban areas when compared to traditional CBA (deSilva 1996).

If the grouping of strategies included measures to identify not only which projects, but the timing, and what combination of projects delivered desirable emerging measures like customer satisfaction then the broadening goals of the transitioning planning process could be addressed. Agencies are trying new methods, developing tools and incorporating strategies to improve this phase of the planning process and make it more transparent internally as well as externally (Sillars 2009, Miller 2002, Kim 2002, Cundric 2008). Oregon DOT developed a project delivery tool to assess selection of methods for timely delivery (Sillars, 2009). This analysis was at the project level but shows innovative problem solving. The multi-criteria selection techniques used in this context could be a blueprint for development of new tools at the program level (Miller, 2002). Indiana DOT (Kim, 2002), in an effort to move away from ambiguous decision making developed a formal Decision Support System (DSS) using an Analytic Hierarchy Process (AHP) to prioritize major capital investments. The AHP is a multi-criteria decision tool that can model quantitative and qualitative criteria. However there are limitations and assumptions inherent in these new tools as well, for example the multi-criteria approach requires an explicit set of objectives set by the decision making body (Cundric, 2008). Moving away from the cost-benefit analysis methods to address the broadening planning goals is occurring on an international scale (Cundric 2008, Hatzopoulou 2008, Zhang 2006, deSilva 1996). Other analysis tools like modified CBA, linear optimization models, DEX, Indicator/Target and multi object models are being investigated for their applicability and value (Zhang 2006, Cundric 2008, deSilva 1996).

There is also research looking at how to compare policy alternatives in the prioritization phase (Zhang 2006). Scenario planning is another tool used to evaluate consequences at different investment levels. The City of Portland uses scenario planning to educate the public and decision makers as well as collect public information regarding the scenarios (Bugas-Schramm, 2008). The scenarios are based upon various levels of service (poor, fair, good) for different criteria (maintenance, cost, frequency, etc).

2.3.3 Performance Measurement

Performance measurement is a step of the planning process, an element of asset management and the basis for most public relations campaigns, and it is a very robust field in and of itself. Kassoff defines performance measures as "indicators of work performed and results achieved" (Kassoff, 2001). There are two types of performance measures outcome based, which links to goals and strategies and output based, measures that link to policies and actions (Cantalupo, 2002). Customer satisfaction as a performance measure is outcome based and has been characterized in two distinct ways: 1) as a roll-up measure of other objective performance attributes (Cantalupo, 2002), or 2) one of the many measures of performance (NTOC, 2005). Both characterizations have merit, there are various subjective measures that affect the perception of performance, for instance, safety is a fundamentally important measure that is largely subjective. The first distinction of satisfaction as a roll-up measure implies that satisfaction is more important than safety, which is not a characterization any decision maker would agree to if explicitly stated. However, in terms of decision making the political nature of the process leads decision makers to decide based upon what voters want, what makes them happy and reelect the decision makers. This tends to be satisfaction based. However the roll-up measure perspective could be said to include safety as a subjective subset of performance measures.

Performance-based planning and decision making is a process in which specific performance targets are identified and resources are assigned to support the attainment of those targets (Pickrell 2001, Meyer 2002, Kassoff 2001). However, it is important to note that the value of performance-based planning is in the process not just the short-term results of system performance (Meyer 2002, Kassoff 2001). Researchers also suggest this approach is not to replace the current process or decision makers but to give structure to a largely political and amorphous step of transportation decision making (Pickrell 2001). Pickerell’s research suggests that the major reasons for performance-based planning are: 1) Accountability, 2) Efficiency, 3) Effectiveness, 4) Communication, 5) Clarity and 6) Importance over time.

There are multiple possible perspectives of performance-based planning, for example, the objective of sustainability inclusion (Zeitsman 2006). Zeitsman et al, compare decision support tools to address sustainable transport priorities. They prioritized which roadway segment should be widened in order to meet their performance goal of sustainability. They found that multi attribute utility theory (MUAT) provided different prioritization results than the traditional single objective techniques. This approach was able to include qualitative data, negative externalities and relative importance of criterion which is extremely valuable when considering subjective performance objectives like sustainability or customer satisfaction.

Incorporating qualitative, subjective elements into an objective evaluation methodology is not a novel practice. The development of the Pavement Serviceability Performance: Pavement Serviceability Index (PSI) concept did just that for pavement measures in the 1960s (Carey, 1960). PSI provided an objective means for evaluating performance, which is needed for a variety of subjective goals, like customer satisfaction, in today's decision making process. PSI development used subjective ratings by a panel of experts to develop the serviceability index which can be used to summarize the pavement's performance over time.

Meyer (2002), investigated the use of system operations data for performance monitoring and found several viable customer satisfaction measures that could be used in decision making. They are: 1- system reliability, 2- travel time (speed), 3- safety, 4- average delay at top x bottlenecks, 5- physical conditions of infrastructure, 6- traveler costs, and 7- customer satisfaction measures (Meyer, 2002). In 2005, the National Transportation Operations Coalition (NTOC) took it one step further and created the Performance Measurement Initiative which convened a broad array of transportation professionals to develop a list and definitions of ten national performance measures (NTOC, 2005). Customer satisfaction was one of the ten selected national measures, only 33% of the 333 organizations surveyed were using customer satisfaction measures. Those same organizations rated it as 3.41 out of 5 (where five was the highest) on a usefulness scale. There appears to be a need for accurate, measurable and consistent customer satisfaction measures in the transportation decision making processes.

2.3.4 Summary of Customer Satisfaction in Transportation Planning

To summarize customer satisfaction in transportation planning it is foremost to note that the planning process is in flux due to the broadening of goals. In the current planning process a ‘tiered’ system matches performance measures to the goals, strategies and actions of the plan. This process is split into technical and political components with public input on either side (front-end by citizen groups, back-end by votes). Current planning analysis tools are insufficient to address the broadening goals; the traditional four-step travel demand model is constrained in its output.

Public involvement is how the planning process gets customer buy-in; it differs from public relations because the input is fed into decision making. However, public involvement activities typically occur at the project level where public input is for a specific scope. The public involvement spectrum is expanding due to innovative use of technology, because it can be difficult to get or keep the public’s interest for broad goals or for prolonged periods of time.

Project selection and prioritization is a more political process with trade-off analysis of legal, environmental and fiscal constraints. Cost-Benefit Analysis (CBA) is common for project prioritization. However, this approach tends to be biased toward urban areas and roadway projects. There are other prioritization techniques and decision support systems (DSS), being used around the country and around the world to make this step more transparent, internally and externally. Some of these tools are multi-criteria assessment, linear-optimization models and scenario planning.

Performance measurement is where the agency measures what it has done, and what it has accomplished. There are two types of performance measures output, which are objective, and outcome, which are subjective. Customer satisfaction in performance measurement has two characterizations: 1) as a roll-up measure, 2) as an equal but subjective measure. The value of performance-based planning is in the process, not just immediate results; it can also affect prioritization outputs. While incorporating qualitative, subjective elements into objective evaluation is not novel, it is not common. The National Transportation Operations Council (NTOC) has included customer satisfaction as one of ten national performance measures.

2.4 Customer Satisfaction in Non-Transportation Literature

2.4.1 Introduction

Customer satisfaction research and application in non-transportation industry is vast. Most of this literature comes from product-based industries efforts to understand, market to, and maintain its market competitiveness. Other research from public administration field is included to show broader government services' challenges and application of customer satisfaction principles. This section begins with a discussion customer satisfaction definition and measurement, focusing on models of customer satisfaction, in doing so data needs are highlighted. Next four key concepts from the product-based literature that have potential in the transportation industry are presented. And lastly the public administration characterization of customer satisfaction is discussed.

2.4.2 Definition and Measurement

This section discusses how customer satisfaction is defined and measured outside of the transportation context. Also customer satisfaction constructs, models and applications that are relevant to the current research are described.

The basic disconfirmation of expectations paradigm (Oliver, 1980), Figure 2.3, identifies that the combination of expectation and performance are antecedents to satisfaction determination, where, “satisfaction is formed through a cognitive comparison of perceived performance with pre-purchase expectations”. This is echoed in many

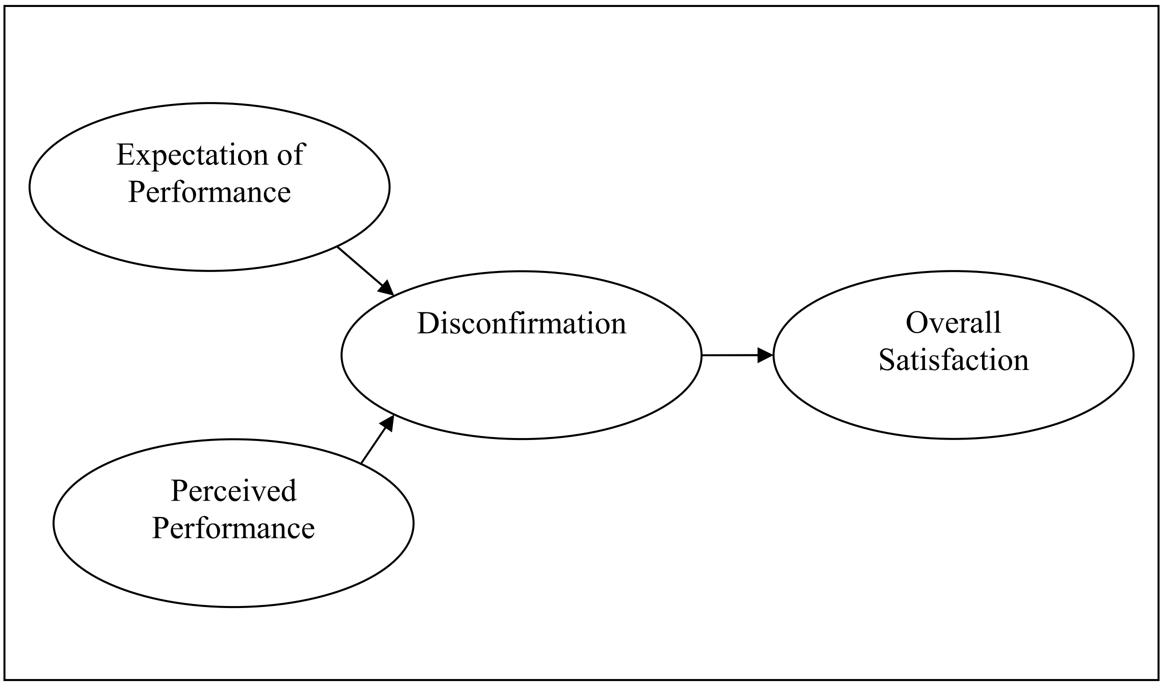

Figure 2.3 Basic Expectancy Disconfirmation Model (from Oliver 1980)

product-based industry researches (Anderson 2000, Chen 2005, Grigoroudis 2004, LaTour 1979, Matzler 2004, Mittal 1996, Spreng 1996, Szymanski 2001). The basic model has been enhanced with other elements such as: 1) The desired level of performance influencing the expectation and perception of attribute performance (Spreng, 1996) where the addition of desires congruency evaluates how well the benefits and outcomes expected relate to the individual’s values. This model posits that expectations are beliefs about a future outcome and desires are an evaluative belief of how an outcome relates to the attainment of higher-level values. It is a parallel process to expectation disconfirmation and an antecedent of satisfaction development. This addition allows for a concrete application and comparison of desires to perceived performance. 2) The concept of information satisfaction as an actionable influential antecedent of overall satisfaction separate but additive to attribute satisfaction and perceived performance (Spreng, 1996). This addition allows analysts to measure the effect of marketer supplied information in the development of customer satisfaction. 3) Perceived quality and perceived value are antecedents to satisfaction (Grigoroudis, 2004). This enhancement separates perceived performance into its quality and value elements which are used to disconfirm expectations and develop feelings of satisfaction. These enhancements to the basic expectancy disconfirmation paradigm allow for operationalization of important elements of the customer satisfaction process.

Another model of the customer satisfaction service quality relationship is the satisfier dissatisfier approach (Pollack, 2008). Pollack combines two research streams, Parasuraman’s zone of tolerance and Herzberg’s two-factor theories. The zone of tolerance theory states there are two threshold levels (acceptable level and desired level) where the relationship between satisfaction and quality adjust. The two-factor theory uses qualitative data to determine the presence of quality attributes: if present they create satisfaction; if absent they create dissatisfaction. Pollack’s research finds empirical evidence that there are three distinct patterns of the quality satisfaction relationship (satisfier, dissatisfier and critical). The satisfier relationship is initially horizontal and positive linear after an inflection point (threshold). Conversely, the dissatisfier relationship begins positive linear then after a threshold becomes horizontal indicating no relationship. Lastly criticals are positive linear with no inflection point.

This concept of attribute type is echoed by Kondo (2001), and Matzler (2004), who have different terms for these asymmetrical and nonlinear attributes but agree that certain attributes behave differently than linear. Kondo calls the Satisfaction Maintaining attribute a must be quality attribute while Matzler coins it a basic factor, the Satisfaction Enhancing attribute is an attractive quality aspect for Kondo and an excitement factor in Matzler's research. Additionally, Matzler identifies a third attribute type that follows a linear symmetric approximation of the satisfaction performance relationship which he calls performance factor.

Halstead (1996) investigates the existence of Domino and Halo effects of the objective service failure complaint behavior relationship. The Domino effect claims that an objective failure in one attribute contributes to the failure in other attributes. The Halo effect is where a single service failure can lead to multiple complaints by the customer for other attributes. This is relevant for customer satisfaction research because there is a vast untapped resource of customer opinion, complaints. However, Halstead finds that complaint information is a complement to the objective service information not a substitute (Halstead, 1996).

DeRuyter (1999), looked at critical service incidents, which is service quality outside the acceptable variation in service provider's performance (zone of tolerance), to understand behavioral intentions. He looked at a cross-section of service industries to identify if there are differences in quality dimensions and behavioral intention. DeRuyter found that there are service industry-specific determinates of quality (deRuyter, 1999). Similarly, Pollack found that the relationship between satisfaction and service quality was not only service industry-specific but also service attribute specific (Pollack, 2008).

Oliver posits that a service experience is not all positive or all negative, and therefore the evaluation judgment of satisfaction must be a balance of these elements and investigate what effects determine the outcome (Oliver, 1993). He combines psychological assessments of satisfaction creation and notes that negative events detract from the ability to experience positive events. The negative looms larger and more salient in the cognitive satisfaction determination (Oliver, 1993; Mittal, 1996). He defines attribute satisfaction as "the consumer's subjective satisfaction judgments resulting from observations of attribute performance and can be considered to be the psychological fulfillment response consumers make when assessing performance"

LaTour's (LaTour, 1979) comparison level theory is an additive function of the weighted by importance discrepancies from the comparison level for each salient attribute, where the comparison level is a function of past personal experience, similar consumer experience, and expectation created by service provider. However his theory assumes no interaction between attributes which is not valid. This research defines expectation as the consumer's beliefs about the levels of attributes possessed by a product. Spreng (1996) takes the definition a step beyond and identifies two types of expectation, evaluative and predictive. Evaluative expectation is some construct of desire and likelihood of occurrence, while predictive expectation is a belief about a products performance at some future time. Spreng (1996) and VanRyzin (2005) both find that expectations can influence perceptions through assimilation of expectation. Figure 2.4, shows the expectancy disconfirmation model with three new causal flow arrows. The relationship indicated by arrow D between expectations and performance is the assimilation effect mentioned above. Van Ryzin finds in his 2005 study that there is a direct effect at F and E.

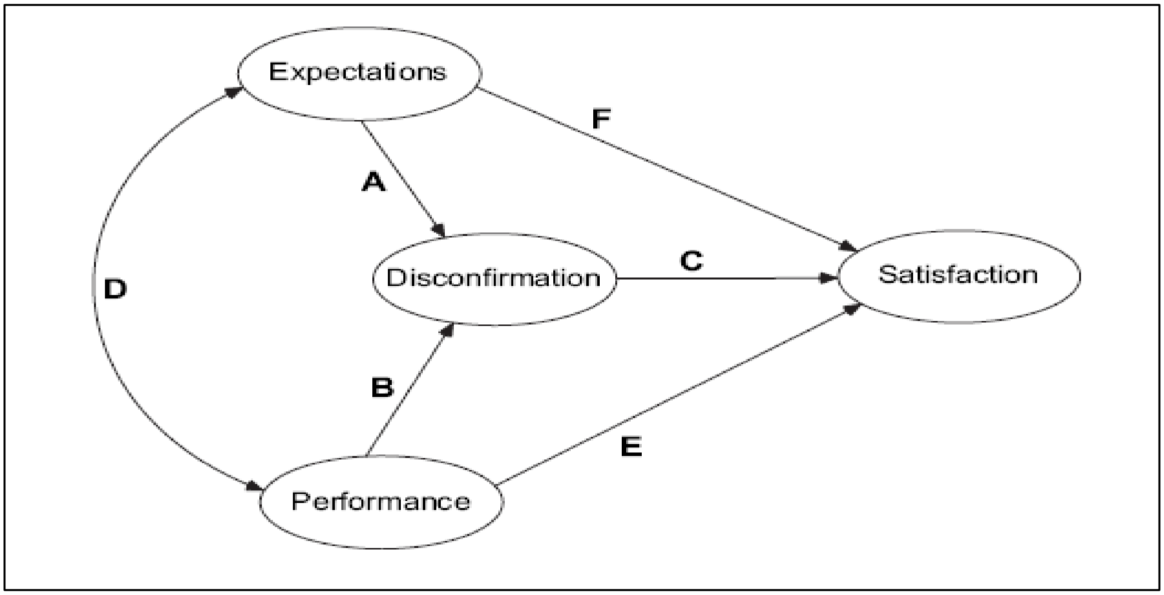

Figure 2.4 Expectation Assimilation Effect (from Van Ryzin 2005)

Even product based researchers are making efforts to systematically transform customer data into actionable product and process parameters. Herrmann, et al. (2000) uses quality functional deployment (QFD) approaches to combine marketing theory with means-end theory to translate voice of the customer into the language of the engineer.

2.4.3 Key Concepts from Product-Based Literature

This section describes four concepts found in product based industry that have relevance to transportation decision making. These concepts are independent but have additive benefits to applications intended to enhance customer satisfaction efficacy. Many of the product based research concepts have some psychological elements that are unusual to transportation related research. However they are necessary to understanding the customer satisfaction development process and how the lessons can be applied in this genre.

2.4.3.1 Concept I: Expectation is a necessary element of attribute performance measurement.

The expectation of performance, along with the actual rating of an attribute's performance give information to the analyst about the disconfirmation of expectation (Figure 2.3). Whether the customer's expectations were met or not and by what magnitude tell a broader story than the individual rating. For instance, a driver that perceives an attribute's performance at a high level (i.e. 5 out of 7) but expects an even higher level (i.e. 6 out of 7) will appear to be satisfied by the performance rating alone since the actual performance rating is greater than the mean of rating scale ($5_{actual} > 3.5_{mean}$). However if using the disconfirmation model we see that the performance actually does not meet expectations ($6_{expected} - 5_{actual} = -1$ does not meet expectation of performance) and therefore have a basis to explain why satisfaction is not at the commensurate level.

Kondo (2001), explains that there are two aspects of quality, and thereby satisfaction determinants, objective and subjective. The objective aspects can be accounted for by measuring the intrinsic attributes of a product or service but the subjective, extrinsic aspect does affect the cognitive development of satisfaction. This means the key attributes that are measurable can only explain a portion of the customer's perceptions of performance that lead to satisfaction.

For transportation applications, this concept can be useful in the design and dissemination of customer surveys and the selection of analysis of those survey data. Foremost, adopting the disconfirmation of expectations model by including the expectation in the question of performance ratings (i.e. How well did this attribute's performance met your expectations?) can give transportation customer survey's more depth to identify and inform the process of how well the service is meeting the customers needs. This also gives the analyst the ability to measure the impact of information to the satisfaction development process (Spreng, 1996). For instance, a marketing campaign that informs drivers of construction zones may impact the expectation of performance and ultimately their satisfaction with the performance.

Additionally, Kondo's findings of hidden and obvious aspects of satisfaction may lead transportation surveys to expand the selection of attributes to those not typically considered for design. For instance the presence of trees has been found to impact satisfaction ratings on urban streets (Pechaux, 2004). However this attribute is not typically a transportation decision making attribute since it is not considered a design feature. Research from product based industry leads us to determine that the extrinsic or hidden values drivers assign are not strictly limited to engineering attributes.

2.4.3.2 Concept II: Importance and performance are not independent drivers of satisfaction.

A common decision support tool, the Importance Performance Analysis (IPA), assumes that the importance and performance ratings of an attribute are independent and can be plotted in a matrix to identify priorities for action. The traditional method collects information from customers regarding key attribute performance and the importance of that attribute to the customer. This leads to a four-quadrant matrix that has high importance high performance in the upper right corner and high performance low importance in the upper left quadrant and so forth (Figure 2.5). This tool is used to identify which attributes, services, or products need remedial action or preventative action based on their importance to the customers and their level of performance.

Quadrants		Importance Rating of Service Attribute	
		Below Average	Above Average
Performance Rating of Service Attribute	Above Average	(4) Maintenance Action: Low Priority	(3) Maintenance Action: High Priority
	Below Average	(2) Corrective Action: Low Priority	(1) Corrective Action: High Priority

Figure 2.5 Importance-Performance Analysis (IPA) Matrix

However, research shows that an attribute's importance to a customer is in part driven by its performance. Anderson 2000, claims there is an 'importance bias' in the traditional IPA matrix design that overestimates the importance of some types of attributes and underestimates the importance of others; this is primarily due to the assumption of a linear symmetric relationship which is described in detail in Concept III. He states that "the importance of an attribute is based on the strength of the relationship between attribute performance and customer satisfaction; the stronger the relationship the more important the attribute" (Anderson, 2000). Echoing this claim, Matzler 2004 conducted an empirical analysis of automotive supplier customer data, separating the dissatisfied and satisfied customers in an IPA evaluation of priorities. He found that this separation led to drastically different priorities and concludes that "A change in attribute performance can be associated with a change of attribute importance."

Hostovsky, a transportation researcher, surveyed various drivers in diverse settings; rural, urban, and commercial. They were asked to identify the most important element of their commute, each driver setting elevated a different attribute as most important. It happened to correspond to the most unreliable element of their trip (Hostovsky, 2004). For instance the urban drivers, rated travel time as most important while rural commuters rated density as the most important. The importance was related to the performance of the attribute. For rural commuters travel time may actually be longer than for urban commuters but its performance was predictable and therefore less important. Likewise for urban drivers density was ‘worse’ than for rural drivers but not as important.

For transportation applications this concept is straightforward, cautioning against over reliance on IPA priorities that assume an independent relationship. Segmentation of driver types can lead to more accurate prioritization schemes and effective strategies to improve customer satisfaction.

2.4.3.3 Concept III: The relationship between satisfaction and attribute performance is asymmetrical and nonlinear.

In most transportation based prioritization schemes it is assumed that the impact of a negative change is equal to the impact of a positive one, a linear association of performance to satisfaction. Stradling (2007), developed a six-step user disgruntlement process, which is an expansion of the IPA process discussed in Concept II, by creating a measure that combines high importance and low performance then plot against importance in a matrix. This measure, user disgruntlement, is an improvement on the traditional IPA but it still assumes a linear relationship of satisfaction to performance.

However from the product-based literature this assumption has been shown to be insufficient at explaining the behavior of all attributes. Figure 2.6 shows the difference between a linear assumption and the asymmetric nonlinear relationship of Satisfaction Enhancing (SE) and Satisfaction Maintaining (SM) attributes (Anderson, 2000).

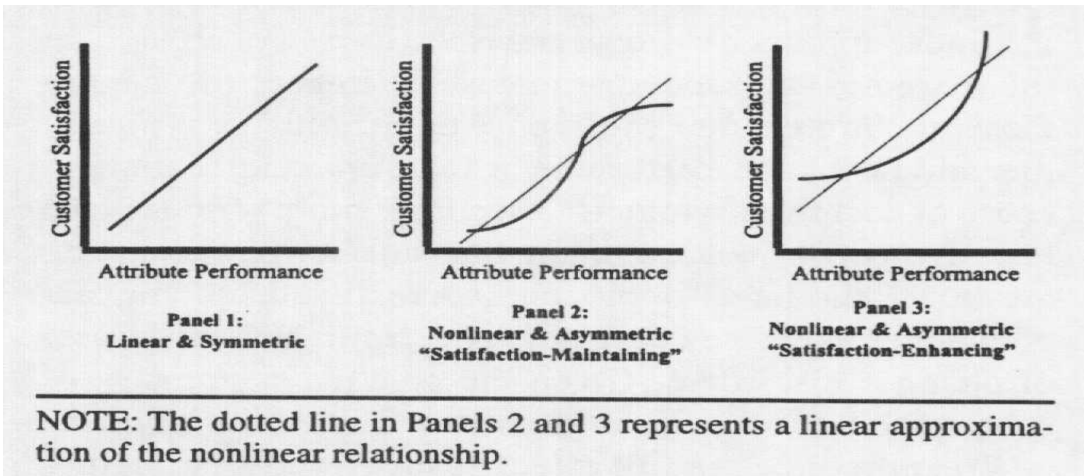

Figure 2.6 Performance-Satisfaction link (from Anderson 2000)

A SE attribute is one that is unexpected or novel while a SM attribute is one that is taken for granted or expected. For example take the case of pavement quality on an urban street; the first panel indicates that an increase in performance (smoothness, rideability, etc) will increase satisfaction by the same proportion. Roads twice as smooth as before will double the satisfaction of customers. However, if pavement quality is a Satisfaction Maintaining attribute, (Figure 2.6, panel 2) we see that at a certain level of performance (smoothness, rideability, etc) the increase in satisfaction is minimal.

Kondo (2001), Matzler (2004), Pollack (2008), and Anderson (2000) found that different attributes have differing impacts to satisfaction for high and low performance. Mittal (1996), provides an explanation of why this may occur "The reasoning is based on prospect theory which proposes that losses loom larger than gains. Psychologically, a one-unit loss is weighted more than an equal amount of gain."

This discrepancy can lead to diminishing returns for agencies that are investing in projects to increase customer satisfaction. This also brings up the issue of a threshold of performance, meaning is it fiscally prudent to provide the maximum performance (the highest rating level) or better to optimize performance (the rating level that maximizes satisfaction): from Figure 2.6 we see that this is not always the same point on the graph. In order to optimize we must know the relationship of the attributes to satisfaction and how the relationship may vary over time, demographics, and geographically. For transportation applications this concept is critical to managing scarce resources. If a performance threshold is determined for an attribute that maximizes satisfaction based on knowledge of the asymmetrical nonlinear relationship, than decision makers can determine the true value of projects, and system improvements to their customers. This threshold concept could also be used to determine which projects and improvements are selected for implementation. For instance, two projects with similar system impacts may have varied satisfaction impacts; this additional information may inform the process to deliver better more satisfying services.

2.4.3.4 Concept IV: Optimize rather than maximize performance

This concept was introduced in concept III, to describe the value of a threshold approach when prioritizing system improvements. Further, the optimization concept introduces the idea that minimizing negative performance for certain types of attributes may actually impact overall satisfaction faster and cheaper than increasing positive performance. Anderson (2000) states it eloquently: “while positive and negative performance of an attribute are two sides of the same coin, each side of the coin buys a different amount of satisfaction". Given the asymmetrical nonlinear nature of some attributes this concept becomes clear. However, Kondo (2001) cautions that "eliminating dissatisfaction is not always the same as achieving satisfaction". It is important in the transportation context that the overall intent and vision of the program is maintained. For instance, a safety program may not have the highest performance rating but it is necessary to strive for maximum performance as well as minimizing negative performance. Conversely, this concept tells us that adding another lane to a roadway to improve travel time may not be as valuable as possibly adding an incident management response program which diminishes the negative impacts and is less costly to implement. Having the means to weigh options from the perspective of the customer's satisfaction is a great addition to the transportation decision making paradigm.

2.4.4 Public Administration Literature

The public administration literature is from the perspective of models of governments and how those structures impact citizens, policies, and services. Transportation is a key public service and therefore the research of how the broader application and implications of government is relevant with respect to its knowledge and management of customer satisfaction.

Customer satisfaction theorists in public administration wrestle with the same dilemmas as in transportation. In the public administration literature researchers agree that customer satisfaction should be more than a public relations tool, by incorporating survey data into policy making decisions (Kelly, 2002). A practical framework and tools to accomplish that goal are lacking in public administration as well. However, there is a desire to link objective and subjective service quality measures, find some correlation between service outputs (service performance/ benchmarks) and service outcomes (satisfaction with service quality) (Van Ryzin, 2004). Additionally, the subjective aspects of service quality have been perceived as less important than physical ones in prioritizing measures; however, service quality is an abstract and elusive construct in both fields because of its three unique features: intangibility, heterogeneity and inseparability of production and consumption (Giannoccaro, 2008). In the transportation context this becomes even more problematic, as services are consumed throughout a network not explicitly at one location like neighborhoods like some public administration services (school system, police service, etc).

Similar to the transportation literature, public administration proponents want to test, and apply private sector models, like expectancy disconfirmation (Van Ryzin, 2004 and 2005), but don't have the ability to act in the same ways as the private sector, like discontinuing services, altering production, and using direct customer satisfaction measures among others (Kelly, 2002). The public administration models also do not have the same assumptions of homogenous products and relatively constant price that private sector models presume (Kelly, 2004). For example, citizens in low-income areas may receive more objective services like police patrols (output) but be less satisfied with that service (outcome). The objective conditions do not always affect customer satisfaction levels as expected (Van Ryzin, 2004). It becomes difficult to correlate these types of measures when there is no theory of their relationship available (Kelly, 2002). It is assumed that there exists a relationship of performance to customer satisfaction and that it is positive (Kelly, 2005). Another departure from the private sector model is that public services are not voluntary or comparable (Kelly, 2005). An example of this is that a citizen may perceive another neighborhood as having better schools but they are paying the same tax price as that neighborhood and they still pay the same tax price if they do not use the school system service at all. Public services may be experienced individually or collectively, whereas private sector services are generally experienced individually (Kelly, 2002).

The public administration literature also identifies there are discrepancies between manager and citizen perspectives. However, reconciling these discrepancies can be problematic and risky for managers, because objective performance systems may meet or exceed internal goals but not reflect external customer satisfaction systems (Kelly, 2005). It can be controversial to challenge the status quo, especially if the agency is performing well based on their perspectives. Also the citizen perspective can be disregarded as having less knowledge of the issues involved (Kelly, 2005). However, the new paradigm of public management defines economy and efficiency entirely in terms of customer satisfaction (Kelly, 2005). This paradigm is outcome driven but dependent on the managers' ability to capture and decipher output measures. These output measures are often objective measures that cannot provide an explanation of how the output affects the outcome (Kelly, 2002). One recommendation of the literature is to use disaggregate data at the neighborhood level to act as a surrogate for race and class groupings and capture the level at which services are experienced (Kelly, 2005). For transportation applications this may not hold true as services are not experienced strictly at the residential location but this perspective could be helpful for segmentation efforts based on travel behavior, and analysis at a disaggregate level may provide better information for policy development.

Van Ryzin (2004 and 2005), has conducted empirical analysis of public administration data to apply the expectancy disconfirmation model and to determine the best measurement of disconfirmation. His 2004 research found that performance has a greater 'indirect' impact on satisfaction than 'direct'. The research used structural equation models of subjective overall performance data of New York City government and summary judgments of expectation and disconfirmation. The disconfirmation was directly measured, in a survey format like "much better than expected" to "much worse than expected"; this approach explained variation in satisfaction better (Van Ryzin, 2004). He concludes that performance is important but is only one component of a more complex customer satisfaction process (Van Ryzin, 2004). He continues this research in a 2005 study which intends to compare disconfirmation characterization/identification in the expectancy disconfirmation model (perceived, subtractive or both). He finds that the model is quite sensitive to the identification of disconfirmation and the subtractive model overestimates the impacts of expectation. The subtractive identification subtracts the expectation of quality from overall quality; it is not directly measured like perceived quality. Similarly, Giannoccaro found that performance was a better predictor of service quality than the difference in values of performance and importance (Giannoccaro, 2008). Van Ryzin suggested a simulation based experimental design for future research which has the ability to vary the local government services under varying manipulations of expectations and performance (Van Ryzin, 2005). Also, the retrospective collection of customer expectations is a validity issue that should be addressed in future experimental design.

2.4.5 Summary of Customer Satisfaction in Non-Transportation Literature

Main points of this section are that there are several working models of customer satisfaction outside of the transportation context. The most basic of these models is the Expectancy-Disconfirmation model that subtracts perceived performance from expected performance to develop customer satisfaction. A potentially untapped customer information resource, complaints, can be used to complement the understanding of customer satisfaction. There is a service-industry and service attribute specific relationship of customer satisfaction to performance, which means it is not generalizable across industries or attributes. Customer satisfaction is largely a cognitive even where, negative and positive elements balance with external features to determine the outcome. Expectation of performance is a fundamental element in customer satisfaction development. There is also evidence that expectation influences perceived performance through assimilation.

There are four key concepts from product-based literature that is applicable and valuable in the transportation context, individually or collectively. First, it is necessary to expand the transportation survey data collection. Specifically, collect expectation of performance because it allows for more analysis methods and customer satisfaction models. One model states that there are extrinsic or hidden values customers assign which are not strictly limited to objective (engineering design) attributes. This knowledge could justify expansion of attributes used in transportation context. Secondly, the Importance-Performance Analysis (IPA) matrix needs modification to remove the assumption of independence. Attribute importance is in part driven by its performance, which suggests that careful segmentation based on customer behavior and environment may be valuable in the transportation context. Next, third concept is the customer satisfaction-performance relationship is not consistently linear. Several product based researchers have found three general types of attributes that have distinct behavioral relationships. The three types are shown in Figure 2.5, where the third type is indeed linear. Prospect theory, where losses loom larger than gains, may explain why some attributes are asymmetrical and nonlinear. This asymmetrical nonlinear relationship can lead to diminishing returns. In the transportation context, it would be valuable to determine this threshold in order to optimize satisfaction but not over allocate to increase performance beyond the threshold. Minimizing negative performance may have faster, cheaper impacts to satisfaction for some attributes with asymmetrical nonlinear relationship of customer satisfaction and performance.

Customer satisfaction applications and research in public administration context wrestle with the same dilemmas as in the transportation context. They are also lacking tools to link subjective and objective measures to find correlations between policy outputs and outcomes. Applying private sector customer satisfaction models proves problematic due to inherent differences and assumptions like voluntary or comparable services, homogenous products and relatively consistent prices. Also the public sector does not have the ability to modify production, discontinue services or directly measure customer satisfaction. The discrepancies between the manager's and public perspectives can lead to disregard for public opinion or systems that do not reflect customer satisfaction issues. The public administration context depends on output measures that may not be able to explain the subject outcomes desired. One technique suggested is to disaggregate evaluation and analysis at the neighborhood level because it is a proxy for racial and class groupings plus it is the level at which services are experienced. Public administration researchers echo other product-based findings that performance is important but is only one component of complex customer satisfaction process.

2.6 Synthesis of Literature

This chapter has presented research findings, concepts and ideas from varied research pools to characterize the current thinking on customer satisfaction. This literature review frames the current issues, opportunities and challenges to implementation as it relates to customer satisfaction in transportation decision making.

Many of the disparate fields investigated have the same desire to link the subjective and objective elements of customer satisfaction in order to provide better services and services that are aligned with their customers' perspectives. Transportation planning and design, public administration and product-based industry have developed tools to accomplish these goals. However, selecting a tool that fits into the transitioning planning process is not an easy task. It must be simple enough for public, technical and political stakeholders to use, while complex enough to accommodate objective and subjective data and the trade-offs necessitated by the transportation decision making process.

There is opportunity though; there are more sophisticated models of customer satisfaction that have the ability to accommodate transportation decision making needs. However, the data required to populate those models is not common to transportation. In order to advance the field the survey design and analysis methods used for customer data must be expanded. Public involvement practices are utilizing technologies in a way that make communication with customers far more accessible than before, also accessing untapped customer data resources like complaints may prove valuable to the understanding and integration of customer satisfaction. Also formalizing the usage of customer satisfaction could immediately improve the process.

Accepting that some implicit assumptions must be validated in order to improve the decision making process, not only the technical aspects but the framework in which customer satisfaction has been interpreted in transportation must be revamped. Once these assumptions have been tested and tools have been designed to accommodate the true nature of customer satisfaction there is still a need to integrate the knowledge within the decision framework of transportation decision making. This element is the most vital and has the farthest reaching impacts. Envisioning customer satisfaction as a tool not just a goal, to reach stakeholders and provide more effective, efficient and satisfying transportation services.

So the question becomes, if customer satisfaction is a decision making tool, can it link objective and subjective elements for better services and justification of resource allocation without the implicit assumptions of a linear performance-satisfaction relationship? Will it accommodate broadening transportation goals? And can it be done in a systematic empirical process that is easy for multiple stakeholders to understand and explain? These are the questions that frame the exploration and experimentation of this research and they are outlined in the next chapters.

CHAPTER 3

PROPOSED FRAMEWORK

3.1 Introduction

This chapter describes the proposed framework, and its attributes of feasibility. This chapter first presents a discussion the research approach, walks through the proposed conceptual framework, and then suggests potential applications of the framework in the current transportation decision making process.

3.1.1 Research Approach

This research is exploratory in nature, examining the usage of customer satisfaction in the transportation decision making process and exploring how it can be used in an analytical application. This research topic bridges diverse industries infusing their findings in a transportation context. The final product of this research is a framework for using customer satisfaction in the transportation decision making context. Each of the three research tasks help direct the development of the framework by: 1) investigating the decision making structure, 2) collecting input from targeted system users and 3) testing the applicability of implicit assumptions.

3.1.2 Data Analysis

The data collected and used in the development of this customer satisfaction framework are both qualitative and quantitative, from direct and indirect sources, meaning some data are collected via surveys and document reviews where other data are from previous research studies. However, the end use of the data is to form the development of the customer satisfaction framework for integration in the transportation decision making process. This ultimate goal guides the selection of data sorting, coding, statistical analysis and presentation methods. The mix of qualitative and quantitative data and analysis methods highlights the challenges of using customer satisfaction as an analytical tool in decision making. Every effort is made to select the most common and parsimonious methods and presentation for a broad range of audiences, utilizing data typically available in the transportation context.

3.1.3 Validation Process

The proposed customer satisfaction framework is intended to be a skeleton model of the findings from this research and how it might be implemented in a real-world transportation setting. However, data availability and lack of analysis methods limit the applicability of the framework at this stage. Validation of the framework prior to the recommended experimental design modifications identified in chapters 5 and 6 is premature.

3.2 Proposed Conceptual Framework

The framework highlights major elements and tasks that are central to a more customer satisfaction focused process. The conceptual framework is a map of how this research was undertaken and the theoretical principles investigated through the research tasks. The conceptual framework for this research is based upon the traditional planning process model first introduced in the literature review chapter. This model was expanded to integrate customer satisfaction measures and tools in three primary stages of the process, as highlighted in Figure 3.1. In addition to changes in these three discrete steps of the transportation planning process, customer satisfaction integration has an overarching

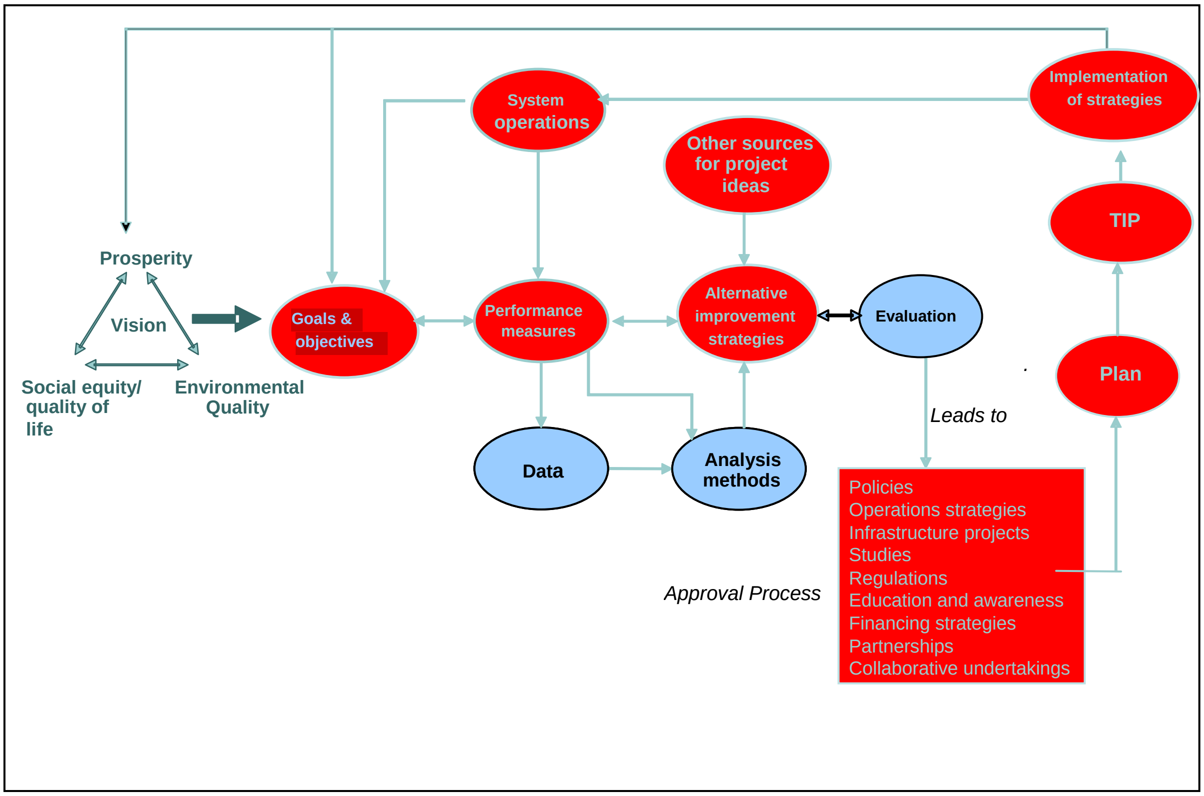

Figure 3.1. Proposed Customer Satisfaction Framework

effect in the process as well as the assumptions implicit in decision making. The development of the framework was influenced by information from the literature as well as the practitioner survey results and documents from targeted agencies. Ideally, integrating customer satisfaction measures in every step of the process would provide a greater impact. However, these major areas are highlighted because these are the elements of the decision making process that are directly and explicitly influenced by customer satisfaction knowledge enhancement in the transportation context. Incorporating customer satisfaction in these select stages of the process can impact the decision making outcomes by providing additional evaluation criteria for decision makers (see discussion chapter 6).

Each of the three stages of the proposed framework are intended to be additive. For example, the data stage recommendations can be implemented without the analysis methods or evaluation stage recommendations. However implementing the evaluation stage recommendations require that the data and analysis methods recommendations be implemented. Because of the nature of this research the earlier stages are more definitive than the latter stages of the framework, this means that the data stage recommendations are more formulaic, and the later stages (analysis methods and evaluation) are dependent upon the results of the data stage recommendations being implemented.

The proposed framework presents direct and indirect impacts on the current decision making process, methods to assess customer satisfaction in the process, identifies challenges to implementation and offer potential tools to address those challenges. Each of these stages and the overarching impacts to the planning process, as well as the attributes of feasibility for the framework are described in this section.

3.2.1 Data Stage

Impacts of integration

This step of the planning process (Figure 3.1) is where data is collected and matched to performance measures and analysis tools. The performance measures dictate what data is collected, interpreted and therefore advanced to decision makers (Meyer, 2002; Handy, 2008). The customer satisfaction framework proposes that additional data is required to populate new and modified analysis models. Specifically, the expectancy disconfirmation model requires expectation of performance data. Additionally, performance ratings to correlate objective and subjective performance should be collected on surveys as well as objectively with instruments.

Indirectly, inclusion of customer satisfaction data would impact the public involvement process requiring not only modified customer surveys but avenues to communicate with the public to attain the goal of transparency. It would also impact the performance measurement step, having applicable data for analytical analysis of customer satisfaction could lead to more expansive customer satisfaction performance measures.

Assessment of process

Questions transportation professionals need to answer to assess whether their process considers customer satisfaction in a meaningful way:

- Are there explicit performance measures for customer satisfaction?
- Do performance measures have data to answer the goal of customer satisfaction?
- Do you collect customer satisfaction data?
- Do you conduct customer surveys?
- Does the current customer survey collect customer satisfaction attribute data?
- Does the current survey collect expectation of performance data?
- Is customer satisfaction a goal or objective for the agency?
- Does the vision of the region include customer satisfaction?
- How is Quality of Life defined? Does it implicitly include customer satisfaction?
- Can current survey design provide data for customer satisfaction models?

- Does current survey design segment customers?
- If segmentation is used, are categories defined by travel function, or travel behavior?
- How does the agency define customers? Satisfaction? Quality of life?
- Are decision makers requesting customer satisfaction statistics/information?

This is a starting point to identify if agencies would benefit from including customer satisfaction measures in their decision making process.

Challenges to integration

Some of the challenges to integrating customer satisfaction at this stage are the additional expense to either collect additional data or modify the existing data collection efforts to include customer satisfaction measures. Also, this stage is heavily dependant on having adequate and appropriate analysis methods to utilize the new data.

3.2.2 Analysis Methods Stage

Impacts of integration

This step in the transportation planning process (Figure 3.1) typically uses the traditional four-step travel demand model. There are a variety of analysis tools that are in various stages of usage throughout the US and internationally (Cundric, 2008; deSilva, 1996). The broadening of transportation goals has forced the industry to consider new tools that provide the desired measures of effectiveness (Kelly, 2002). However, the four-step travel demand model is the central model used by planning agencies. It also acts as the basic structure for many of the sketch planning add-ons available for special analysis (freight, ITS, etc). One notable exception is the activities based model, this model has the potential to address segmentation of customers by travel behavior, which is how trips are categorized in this type of model not by origin/destination pairs. This type of trip generation mimics the segmentation recommendations from the literature that suggests that customer segments are more useful for customer satisfaction analysis if grouped based on trip characteristics and behavior. However, the complexity of the activities-based model may offset the potential benefits in the decision making context.

The customer satisfaction analysis methods recommended for empirical applications require data not typical for demand models. The output and interpretations are not typical either. The development of analysis tools that can be incorporated into the travel demand model is outside of the scope of this research. However the relative impact graph is an analysis method recommended to add customer satisfaction capability without modifying the traditional travel demand model. This analysis method can be done in concert with traditional analysis to add value until integrated methods are developed.

The relative impact graph uses dummy linear regression to determine differential impacts of high and low performance on satisfaction (relative impact graphs are explained in greater detail in section 4.2.3.2). In broad terms this tool is used to identify what type of changes will have the most impact on customer satisfaction and what performance level of an attribute is ideal for the money. Specifically, it reveals the true relationship between individual attribute performance and satisfaction (linear, nonlinear, and/or asymmetric).

The current recommended tool, relative impact graph, has greater explanatory power at the disaggregate level. This tool may be used to establish a threshold of performance for individual attributes that predicts the likelihood of maximizing customer satisfaction. This tool gives agencies an option for empirical analysis of their customer data with respect to investment choices. The ongoing research to include qualitative data, and non-traditional transportation measures will be extremely valuable for the evolving planning process. Rather than developing another tool here, leveraging the tools that are under development will provide greater benefit for practitioners.

Assessment of process

Some questions to answer to determine if customer satisfaction is being used in a meaningful way in the analysis methods phase of the decision making process:

- Do your agency's existing analysis tools assume a linear relationship of performance to satisfaction (for example the IPA matrix)?
- Does your agency currently use customer satisfaction as a measure of effectiveness for alternatives analysis?
- What type of analysis is used for your customer data?

Challenges to integration

Some of the challenges of this approach are the dependence upon future tool development to integrate the process within the traditional models. However, there are valid parallel processes that can be used in the mean time. Also, the aggregation of customer satisfaction measures for project/policy/strategy comparison is an obstacle to full integration of customer satisfaction measures. Customer satisfaction is dependant on temporal, spatial and geographical elements additional research to determine the temporal limitations of relative impact graph should be conducted. The spatial and geographic elements can be addressed through careful segmentation and disaggregate analysis.

Potential tools to address challenges

In future applications other analysis tools like structural equation models and linear optimization could be used to predict the satisfaction performance relationship. Transit agencies have used structural models to measure the impact of policies before implementation (Stuart, 2002). This type of analysis tool uses exogenous variables, those not directly measurable within the system, to predict the impact of unknown factors. This model provides a composite prediction where the impacts of individual attributes are combined to determine the output satisfaction.

Similarly, linear optimization models combine the independent relationship (equation) of attributes to determine an optimal operating point. This type of model is very promising but research to determine the independent equations of the determinate attributes must be determined prior to its application. The relative impact graph may prove useful in determining the attribute performance-satisfaction equations for many attributes. However the temporal nature of customer satisfaction may mean that this type of analysis will require considerable refinement over time. It is a potentially valid tool to aggregate the multiple attributes of a project/policy/program into an actionable format for decision making. Another consideration is the complexity and computation required for linear optimization may require technical expertise outside of the traditional job descriptions.

3.2.3 Evaluation Stage

Impacts of integration

This stage of the planning process (Figure 3.1) is the most political. Decision makers utilize decision support tools to evaluate and compare alternatives in project selection and prioritization. Cost-Benefit Analysis (CBA) is a common evaluation tool used at this step. However, there are various more sophisticated evaluative tools that compare multiple criteria, some including qualitative comparisons. Customer satisfaction at this phase is ad hoc rather than formalized. In order for it to have a meaningful impact on evaluation it must be in an actionable format for decision makers.

Anecdotal customer opinion weighs heavily in this phase because decision makers use the current climate as an indicator rather than a systematic analysis to determine the public opinion (Kernell, 2006). For example, in Minnesota when the bridge collapsed in 2007, safety was of paramount concern for citizens, decision makers, and transportation professionals alike. Therefore bridge safety programs were likely given far more consideration than would have been if the tragedy had not occurred. This is not to say that decision makers should be oblivious to current affairs but a tragedy should not have to occur to justify choices that are not high profile but could produce satisfaction. A tool to forecast customer satisfaction may provide this benefit. An analogy of the current customer satisfaction decision making model is likened to the children's game Hotter/Colder. Where decisions are made then the temperature of satisfaction is taken, via surveys after implementation to find out if they are "getting warmer or getting cooler". But there is no mechanism to determine what aspect or elements of the decisions are having the warming or cooling affect on customer satisfaction and public opinion, which creates the Hot/Cold reaction.

The relative impact graph tool used in the analysis methods stage informs several potential evaluation tools for actionable decision maker formats. A modified IPA that accounts for implicit assumptions can be used right away. The relative impact graph analysis determines the nature of performance-satisfaction relationship which can be positive asymmetrical, negative asymmetrical or linear. This determination indicates if positive or negative performance has a greater impact on satisfaction, or if it is equal in the case of a linear relationship. Since most decision tools assume the relationship is linear any decision support tools currently in use would need modification to account for the true nature of the performance-satisfaction relationship. A modified IPA changes the action recommendations depending on what type of relationship is determined. This is likely more effective at a project level or a smaller analysis, it is impractical for regional decisions however it is an evaluation tool.

The potential impact of determining attribute performance thresholds holds the greatest value for evaluation. For example, knowing that the number of through lanes has already reached maximum satisfaction even though more lanes can be added is not financially responsible. Having a systematic empirical analysis customized for the region in question will provide the resource justification decision makers require to make allocation decisions.

It is also feasible to valuate customer satisfaction for inclusion in CBA evaluations. The relative impact graph could inform the process. The costs of improving performance are known but research to monetize the benefit of customer satisfaction is necessary and could prove valuable in more than the transportation planning process.

Challenges to integration

Some challenges to this integration are the inherent ‘black box’ political nature of the evaluation stage of the transportation decision making process. The political tradeoffs discussed and decided at this stage are far more complicated and intricate than any other phase of the process. Research to develop, verify and maintain a threshold of attribute performance which may have the greatest impact has not been conducted any may prove to be a labor intensive application. However, providing customer satisfaction outputs in an actionable format will give decision makers the ability to justify their decisions within the framework of customer satisfaction and transparency.

3.2.4 Overarching Issue

The implicit assumption of a linear and symmetric performance-satisfaction relationship is a fundamental issue of the current decision making framework. Results of this assumption filter throughout the entire process. It affects the type of data collected, the analysis performed and the evaluation tools available.

Refuting the implicit linear assumption changes the decision making paradigm in allowing for an empirical application of customer satisfaction. This issue directly impacts the analysis methods and evaluation stages. It indirectly impacts the data stage because new analysis methods require new data. However, the greatest impact is in the evaluation stage because implicitly the goal of performance measurement programs has been to maximize performance (Mittal 1996). If the performance-satisfaction relationship is nonlinear and asymmetric it repeals the goal of maximizing performance for maximized benefit. The relative impact graph recommended in the analysis methods stage does not make this assumption and is used to determine the performance-satisfaction relationship.

This overarching issue requires a new paradigm that accounts for various performance-satisfaction relationship types. It impacts goal setting for performance measures, provides justification and transparency for project selection by applying the empirical analysis and expands the influence of public involvement because customer satisfaction is applied in multiple stages of the process.

These changes could then filter back into the process by affecting the goals and objectives of plans, targets of performance measures and the type of improvements set forth to evaluation and selected for implementation.

3.2.5 Framework Attributes of Feasibility

This section lists attributes for the proposed customer satisfaction framework, used to determine if the framework is feasible to access the customer satisfaction practices of transportation agencies. These attributes were determined from the literature and survey of practitioners they represent organizational, institutional, technical and application-based elements of a good framework.

- <u>Formal procedure for usage of customer satisfaction data.</u>

  This attribute requires a standardized approach to using customer satisfaction data and that that approach be formalized. Specifically, written procedures have the most potential for institutionalization. This is important because a multi-faceted multi-division organization will have employee and leadership turn over. A formalized procedure raises the priority of customer satisfaction within the organization and reduces the likelihood of confusion during turnover. The literature and practitioner survey highlighted the need for formal written procedures, not just a line item in strategic plans or vision statements but an operating plan for how resource decisions will be affected. It should have clear identification of responsibilities and information flow within and outside of the agency.

- <u>Standardizes data collection</u>

This attribute requires that the data collected in customer surveys be standardized. This is so each organization that embarks on developing a customer satisfaction program does not have to reinvest time already spent researching data requirements for customer satisfaction practices. Also, it makes comparison among jurisdictions possible. The literature suggests that the expectation of performance, attribute performance and satisfaction ratings are needed to populate the expectancy disconfirmation model which is the basis for the analysis methods used in the framework. The targeted practitioner survey identified that the type of data collected varies by agency.

- <u>Is a systematic analytical model for customer satisfaction in decision making.</u>

This attribute requires that the framework be systematic, meaning each potential user is able to achieve the same results. The model and analysis are not subjective and based upon sound empirical processes.

- Uses existing data as much as possible, leverages existing resources.

This attribute requires the framework to use existing data sources. From the literature it was clear that transportation agencies collect a vast amount of customer information.

- Simple to use and explain, yet appropriately complex to accommodate customer satisfaction elements.

This attribute requires that the framework analysis is parsimonious and commensurate to the problem. Customer satisfaction is a complex phenomenon but the framework should make the analysis clear, concise and appropriate to the level of user. There are many analytical methods that could be used to estimate customer satisfaction. However, the complexity of the method is a priority in its value as a framework element.

- Conducts an empirical analysis of customer satisfaction.

This attribute requires that a mathematical procedure to analyze customer satisfaction be the basis of the framework.

- Fits into current transportation planning framework.

This attribute requires that the framework adhere to the same processes as the transportation planning framework.

- Uses both qualitative and quantitative data.

This attribute requires that both types of data, qualitative and quantitative be accommodated within the framework.

- Address both technical and political aspects of transportation planning process.

This attribute requires that the framework integrate customer satisfaction practices in the technical elements as well as political stages of the decision making process.

- Is flexible to accommodate customization and adaptation (ie new analysis methods) as they become available.

This attribute requires that the framework be adaptable to new circumstances and scenarios unknown at the time of development.

These attributes are identified as being markers of a good framework, a framework that can assess the customer satisfaction practices of an agency and improve the usage of customer satisfaction in decision making.

3.2.6 Potential Framework Applications

This section presents concepts from the literature and framework development that have application value in the transportation industry to improve the use of customer satisfaction in decision making processes through better understanding of the findings from customer satisfaction researches. Table 3.1 identifies multiple opportunities for this knowledge to impact traditional approaches to customer satisfaction and how it may benefit the industry. The applications are based upon existing planning processes and expand the usage of customer satisfaction from a marketing and public relations effort to a decision making tool with empirical analysis to support and justify its claims.

Table 3.1 Potential Applications of the Proposed Customer Satisfaction Framework

Current Transportation application	Applicable Research	Customer Satisfaction Improvement
Survey design	*Kondo, 2001 says that key attributes that are measurable only explain a portion of customer's perception of performance	- Add or reform questions to measure performance expectations -Include non-design attributes in surveys to measure extrinsic value * - Use disconfirmation paradigm
Prioritizing projects/ improvements	* Hostovsky 2004, finds that different segments (type based on driving environment) of customers have different perceptions of importance and performance	- Assist in segmentation of customers * - Improve and provide additional analysis methods for customer data - Reduce use/dependence on IPA
Project selection and prioritization	* Anderson 2004, theoretical asymmetrical nonlinear relationship of satisfaction to performance explains behavior of some attributes	- Additional selection criteria for projects that is intuitive - Better understanding of the performance satisfaction relationship *
Resource Allocation	* Pollack 2008, finds empirical validation of three distinct performance-satisfaction relationships with break-point identifiers (thresholds)	- Develop a threshold of optimal attribute performance that maximizes customer satisfaction. *
Resource Justification	* Oliver 1993, Prospect theory suggests better savings by reducing negative performance because a unit loss looms larger than an equal unit gain.	- Identify impacts of increase positive vs. reduce negative performance

Survey design

The potential application of the literature and framework recommendation on this current application may expand the scope of transportation surveys. Specifically, including extrinsic attributes, for example presence of trees which has been found to impact perceptions of satisfaction (NCHRP, 2008; Flannery, 2006; Pecheaux, 2004) but is not a traditional survey attribute because it does not link to design attributes like volume to capacity ratios. See chapter 2 for a description of the concepts and chapter 5 for a demonstration of this application.

Prioritizing projects/improvements

A potential application is to segment customers based on driving behavior in data collection efforts since their perceptions of importance and performance are linked to their segment type. This is described in chapter 2.

Project selection and prioritization

This element of the decision making process relies on implicit assumptions of the performance-satisfaction relationship being linear. Potential applications can reduce the dependence on this assumption. Chapter 6 provides more detail on this application.

Resource Allocation and Resource Justification

Potential applications require additional research to determine threshold of performance based upon the asymmetrical nonlinear concept of attribute performance to customer satisfaction relationship. Chapter 6 discusses these applications in detail.

3.4 Summary

This chapter introduced the proposed framework and how it will integrate with the transportation decision making process. Three stages of the existing process are highlighted to detail opportunities for customer satisfaction application. Identifying the shifting paradigm of transportation decision making to customer focus and how customer satisfaction research can play a role in shaping the future of transportation decision making process was discussed. This chapter also provided attributes to determine the feasibility of the proposed customer satisfaction framework.

In the next chapter the theoretical methodology is described for the three research tasks used to develop this framework. Chapter 5 provides the results of the tasks, process review, practioner review and asymmetrical nonlinear concept test. Then Chapter 6 discusses the key findings and appraises the feasibility of the proposed framework and lessons learned from this research.

CHAPTER 4

METHODOLOGY

4.1 Introduction

This chapter discusses the research tasks and methodology to develop and verify the proposed customer satisfaction framework discussed in Chapter 3. The theoretical underpinning of data collection, coding and analysis are described in this chapter. Chapter 5 discusses the research tasks and results in greater detail and Chapter 6 provides a discussion of those results, key findings and the proposed framework feasibility.

4.2 Research Tasks

4.2.1 Planning Process Review

The first step in developing a customer satisfaction framework is to review the current process. As discussed in the literature review (section 2.3) the planning process has various input phases for citizen and stakeholder groups. The process is an amalgamation of qualitative and quantitative analysis points. Therefore customer satisfaction integration as an analytical input should overlap a quantitative analysis element of the process as well as the traditional qualitative input areas.

4.2.2 Practitioner Review

Customer satisfaction applications in the transportation context are still very new and pioneering agencies in this field were selected to identify the methods, institutional and technical issues, and processes used. Therefore a survey of DOT and MPO practitioners with best practices in using customer satisfaction including data was developed. Surveying existing users and early adopters is a way to share best practices and reduce the turbulence of implementing a new framework for potential users.

The survey also allows the framework development to build upon existing policies and practices that enhance the value of customer satisfaction integration.

4.2.2.1 Practitioner selection

Since customer satisfaction usage is still a new field focusing the survey on agencies that have some experience in applying customer satisfaction practices was determined to be more valuable in developing a framework than a national canvas of transportation agencies. Most MPOs and DOTs collect customer data, primarily for marketing and public relations efforts, as discussed in the literature review chapter, however the use of customer data in a decision making context is not as common. The selected agencies use the data at varying levels of analysis and decision making however it is a promising movement.

The practitioner selection process included an extensive literature search for agencies publishing reports or scholarly articles for customer satisfaction and or empirical application of customer data in the decision making process. Also, discussions with planning experts (Dr. Michael Meyer of Georgia Institute of Technology, and Margaret Campbell Jackson of Howard/Stein-Hudson) and organizations designed to track and monitor trends Association of Metropolitan Planning Organizations (AMPO) and Federal Highway Administration (FHWA) lead to the selection and refinement of survey recipients. Additionally a mixture of agencies, both MPO and DOT was desirable to see if there is a difference in the usage of customer satisfaction practices. The eight (8) agencies selected for survey are: Delaware DOT, Maryland SHA, Florida DOT, Minnesota DOT, Puget Sound MPO, Atlanta MPO, Washington DC MPO and Chicago MPO.

4.2.2.2 Survey instrument

The survey instrument gathers relevant information regarding the agencies use of customer data (collection, analysis, dissemination) as well as the Institutional, Technical and Data issues relevant to it's application in a decision making context. See Appendix B for the survey instrument as disseminated to select practitioners listed above. The relationship of the survey instrument to the framework development is key, using the literature and process review as a basis for survey question selection. The survey responses directly impact the development of the framework therefore question selection were critical.

4.2.2.3 Practitioner document review

The next level of analysis was to investigate the practitioner's planning products specifically the Long Range Plan and as available the performance and monitoring plan. This investigation is intended to find if customer satisfaction is a goal and how it is measured at the decision maker level as well as at the practitioner level. Since the planning process involves multiple levels of participants/stakeholders (customers/citizens, policy makers, technical staff, other public agencies, etc) it is valuable to identify if the customer satisfaction goals are present throughout the process and to what extent the planning products support those goals. Many customer satisfaction processes are ad-hoc, as described in the literature review, this step is to identify how pioneering agencies are translating the traditional ad-hoc process to an institutionalized practice.

4.2.3 Asymmetrical nonlinear concept test

The purpose of this investigation is to test the implicit assumption of linearity in many transportation context prioritization schemes. This assumption is a major investigation area of the conceptual framework and a key concept from other industry as described in chapter 2. The theoretical approach discussed in this section has been used in product based research prior (Anderson 2000) and where applicable specific transportation context adjustments have been made and identified.

The hypothesis is to measure if the impact of negative performance is different than the impact of positive performance on the satisfaction of customers. If so, this would indicate a nonlinear asymmetric relationship.

4.2.3.1 Theoretical methodology

The first step is the selection of attributes for investigation, in this case we want attributes that are: 1) observable meaning the driver can sense the attribute such as lane width versus density, 2) tangible these are attributes that can be measured objectively such as lane width versus comfort, and lastly 3) actionable attributes this means a decision can be made to improve or enhance the attribute such as lane width versus setbacks (Anderson, 2000). It is important to note that for the third selection criteria some non actionable attributes may impact satisfaction. However, if it is out of the purview of transportation decision making authority than it is less relevant for prioritization.

The next step is evaluation of the distribution of the selected attributes to decide which statistical applications are valid. This can be done by graphing the distribution of responses to determine if the attribute is parametric (ie normal), or nonparametric. Nonparametric statistical methods are not as powerful however they can be used to make probabilistic inference regarding the data.

Since the type of data most common is rating responses to survey questions by customers the data is likely to be ordinal, it can be ordered and has a nominal value but the relationship between the response values is not an interval. This defines some of the statistical applications available to evaluate the data.

More tests of the responses to determine which statistical tests are valid include tests of rating independence and tests of correlation (across treatments and across respondents). The Spearman's rho test (Spearman rank correlation coefficient) is used to quantify the strength of association between variables measured at the ordinal level.

$$\rho = 1 - \frac{6\sum D^2}{N(N^2-1)} \qquad \text{(Eqn. 4-1)}$$

Where:

D is difference between the ranks of corresponding values of X and Y, and

N = the number of pairs of values.

Testing the correlation between variables will also assist in selecting the appropriate statistical analysis tests, for instance independent variables will utilize different approach than if they are correlated.

For nonparametric data independence test can be conducted using the Friedman Test for samples. The rank based Friedman Test is a nonparametric alternative to analyzing randomized block design, where a block is the respondent and the treatment is the attribute performance. It is used to analyze differences between 3 or more related groups. Where, the null hypothesis is H_o: all treatment distributions are the same, and H_a: distributions are significantly different. This is measured by calculating the test statistic Fr.

$$Fr = 12/bp(p+1) \sum R_i^2 - 3b(p+1) \qquad \text{(Eqn. 4-2)}$$

where b = number of blocks,

p=number of treatments, and

R_i is the rank sum for the *i*th treatment. Then using the Chi-square distribution table for p-1 degrees of freedom to reject or accept the null hypothesis. These are considered descriptive statistical tests; they provide information about the sample prior to any inference or probabilistic tests.

After evaluating the data distributions for relevant statistical tests we can proceed to the evaluation and estimation phase. First conduct a traditional regression analysis of the data. This step will give a baseline measure to compare against the high performance and low performance regression analysis. Noting the purpose of this evaluation is to determine if the impact of negative performance is different than the impact of positive performance on the satisfaction of customers.

Next the responses should be separated into high performance and low performance. If the data collection design includes an expectation of performance the ratings could be split into three categories: exceeds, meets and fails to meet expectations.

However the two performance categories (high/low) are the minimum. Selection of the break point of high performance and low performance should be carefully determined. Using a mean value of the ratings is feasible; however a ‘meets expectation’ rating if available would be ideal. This is noted here because the mean value of response ratings and the ‘meets expectations’ rating may not be the same depending upon the sample and population. Alternatively if the data does not include ratings for performance a measured mean value can be used to determine high performance and low performance attributes, this is not ideal but can be used to segregate responses for regression analysis.

After separating the responses by performance, a dummy regression is conducted for low performance attributes and for high performance attributes. Each dummy regression coefficient should be noted, as well as the R^2 value and F test statistic. The dummy regression process essentially removes the effect of the removed variable from the regression, ultimately identifying the affect the remaining variable has on the outcome variable. In this instance what effect high/low performance has on customer satisfaction. This is done by recoding the data so that high/low performance is either a 1 or 0 (dummy term) in the equation:

$$y= \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \varepsilon \qquad \text{(Eqn. 4-3)}$$

Where, y = customer satisfaction, β = regression coefficient, x_1 = high performance, x_2 = low performance and ε = error term. As you can see from the equation when one is ‘on’ the other is ‘off’.

4.2.3.2 Relative impact graphs

To better capture the effect of this dummy regression a relative impact graph is created to show the relative difference in coefficients and the directional impact of both high and low performance on satisfaction. Figure 4.1 shows an example relative impact graph. The left side of zero in figure 4.1 is low attribute performance impact on satisfaction

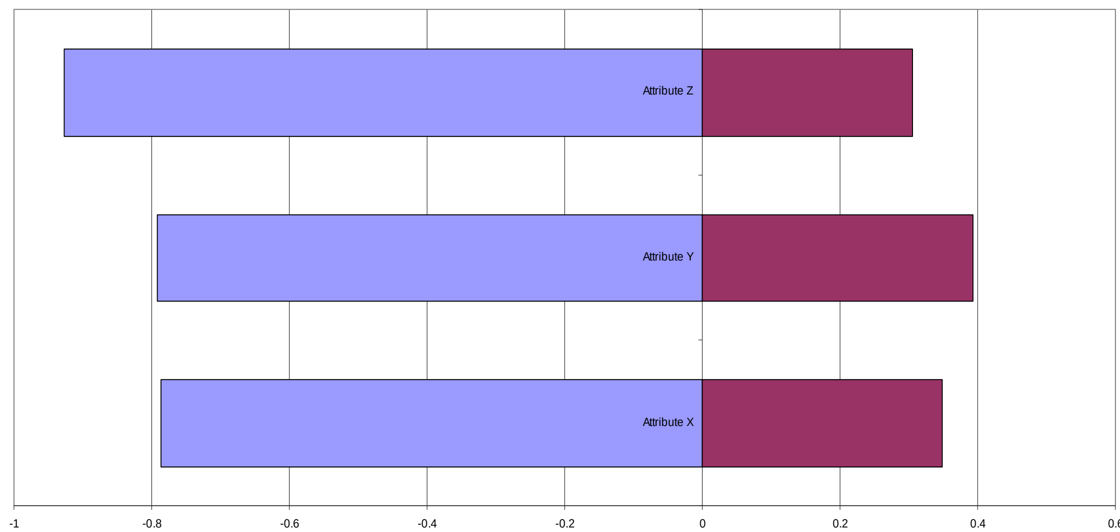

Figure 4.1 Example relative impact graph

and the right side is high attribute performance impact on satisfaction. The relative magnitude difference between the coefficients on each side indicates which performance (high/low) has more impact on satisfaction. From this figure low performance has the greater impact. Also this figure indicates the relationship, direct or indirect, of performance on satisfaction. Because each type of performance attribute falls on the "appropriate" side of zero the relationship is direct. However, it is feasible that an indirect relationship may occur for some attributes. For example, number of lanes may have an inverse impact on satisfaction in areas that value a "small town feel".

This application has been used in product based research (Anderson 2000, Matzler 2004) to study the impact of policies on satisfaction in mutual fund and automotive supplier contexts. The researchers utilized relative impact graphs to determine the relationship of attribute performance to customer satisfaction and verify asymmetrical nonlinear relationships.

The relative impact graph can be interpreted and illustrate relationships better at a more disaggregate level, an example of this is provided in the next chapter. Investigation into this area leads to the next step which is to reorder data by selected subset populations, or segments. The most intuitive subsets to investigate would be to repeat dummy regression analysis by region, and attribute. However, depending on the purpose or decision making context it may also be feasible to conduct analysis by socioeconomic groups, neighborhoods, etc.

Lastly testing the significance of the dummy coefficients is conducted to measure the statistical difference between them, using the F test to test statistical significance.

There are other ways to test for nonlinear asymmetric relationships; this method was selected for its ease of understanding, its ability to use traditionally collected data and the graphical representations of the relationships.

4.3 Summary

This chapter describes the three research tasks 1) Planning process review, 2) Practitioner survey and document review, and 3) Asymmetrical nonlinear concept test. The research is a mix of qualitative and quantitative analysis to support the proposed customer satisfaction framework integration in transportation decision making process.

CHAPTER 5

RESULTS

5.1 Introduction

This chapter describes the results of the three tasks identified in theoretical methodology Chapter 4. First the review of the transportation planning process, next the survey of targeted customer satisfaction practitioners. The interdependent nature of these tasks required an iterative approach, allowing the findings from one task to lead the actions of the next task then refinement of the approach and conducting the reviews again. And lastly the concept test of an asymmetrical nonlinear customer satisfaction to attribute performance relationship.

5.2 Planning Process Review

This section discusses the results of a comprehensive review of the existing planning process to determine where customer satisfaction practices are currently housed as well as identification of opportunities for integration of empirical customer satisfaction procedures. The first iteration of the review identified three phases where customer input was used either formally or informally within the planning process (Figure 5.1). The visioning, performance measurement, and system operation phases of the process are where public input are collected, considered and used.

The visioning phase uses survey data as well as citizen groups to identify needs, wants and satisfaction with the services being offered and future services. The performance measurement phase uses customer satisfaction as a goal, whether or not there are procedures for measuring it. And lastly, the system operation phase includes surveys and customer input during operation of services as well as specific data

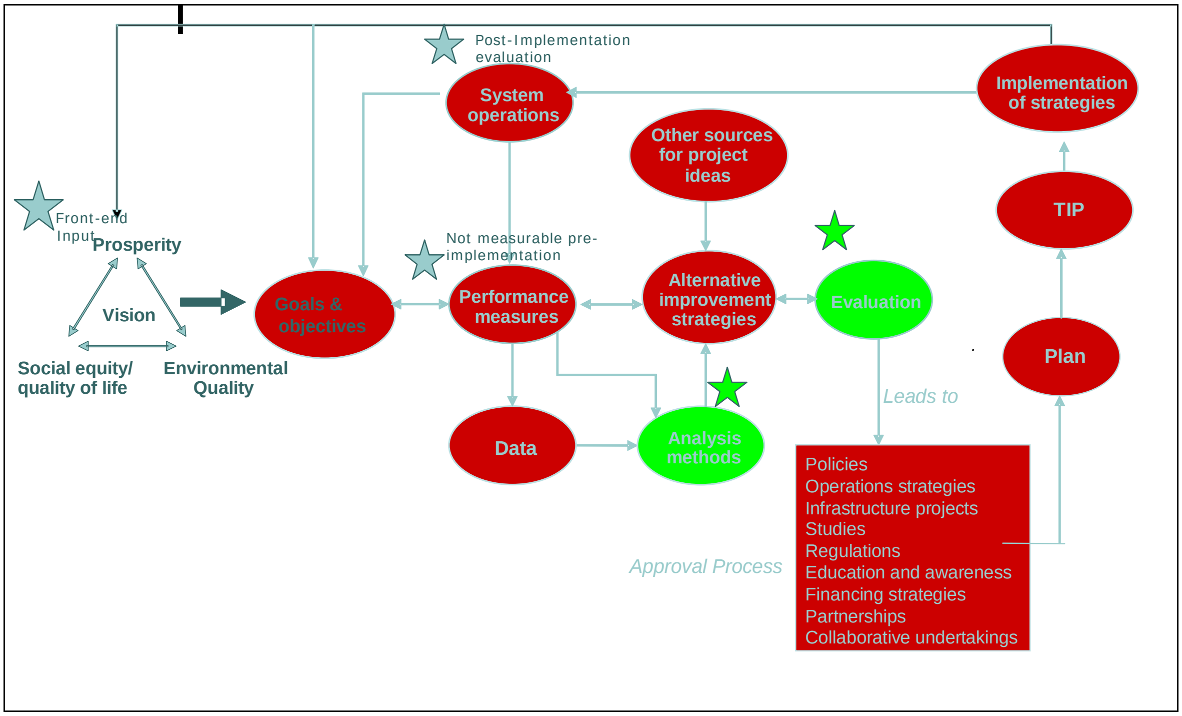

Figure 5.1 Planning Process Review (first iteration)

collection efforts related to system performance to evaluate if goals were met for selected alternatives.

This first iteration review also identified two potential customer satisfaction application opportunities the analysis methods and evaluation steps of the process (Figure 5.1). These steps of the transportation planning process have the greatest opportunity to apply empirical customer satisfaction procedures.

The second iteration review used results of the targeted practitioner survey and the literature to refine steps of the process that could make use of empirical customer satisfaction procedures (See Figure 5.2). It should be noted that the highlighted steps are opportunities for new customer satisfaction applications within the planning process. The existing customer input is assumed to be consistent.

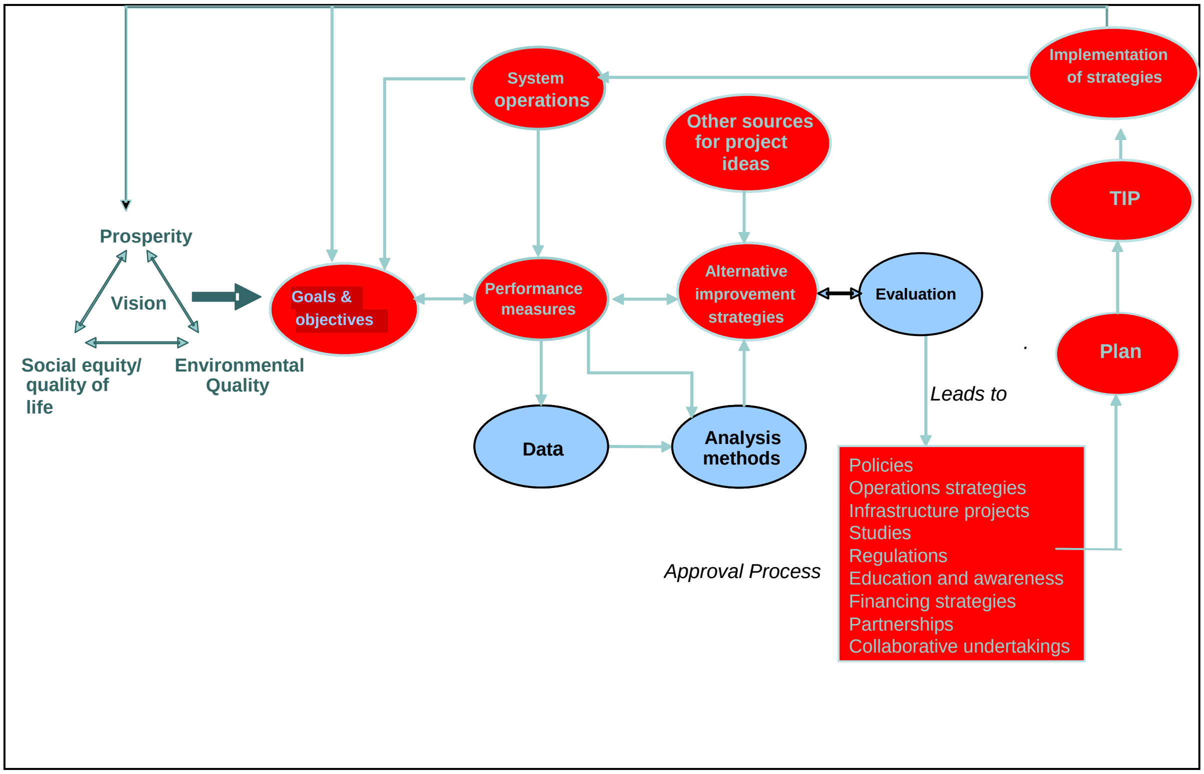

Figure 5.2 Planning Process Review Results (second iteration)

In summary, this task conducted a comprehensive investigation of the transportation planning process to examine phases that currently use customer data, and identify access points within the process where customer satisfaction data can be incorporated. This was an iterative task combined with results of the practitioner survey. The output of this task was used to develop the proposed customer satisfaction framework.

5.3 Practitioner Review

This section provides the results of the targeted customer satisfaction practitioner survey, a comparison of practices, review of those agencies' planning products, and a comparison of the survey results to document results.

5.3.1 Targeted Practitioner Survey

Table 5.1 lists the responses to customer satisfaction survey (see Appendix C for full survey responses). The responses to the first survey led to a second iteration of planning process review and added the data stage to the proposed framework. Then a second iteration survey (Table 5.2) was disseminated online, it was shorter and more targeted to the planning phases indicated in the process review.

Table 5.1 Targeted Practitioner Survey Results (first iteration)

Agency	**Florida DOT**	**Delaware DOT**	**Maryland SHA**	**Atlanta MPO**
Do you collect customer survey data in addition to public involvement data for long-range plan?	Yes	Yes	Yes	Yes
How often do you collect data?	Every two years	Annually	Every two years	Annually
What type of data is collected?				
a. Overall satisfaction ratings	X	X	X	X
b. Individual attribute satisfaction ratings	X	X	X	
c. Performance ratings	X	X	X	X
d. Attribute importance ratings	X	X	X	X
e. Attribute satisfaction ratings	X	X	X	X
How do you identify which attributes to collect customer data for?	Focus groups	Modeled other surveys	Focus groups	
Do you have open feedback questions?	Yes	No	Yes	Yes
What type of analysis is performed on customer data? (frequency analysis, gap analysis, etc)	frequency analysis, cross tabulation analysis, trend analysis and qualitative analysis	trends analysis	frequency analysis, gap analysis, trends analysis and Customer Satisfaction Index (Importance-satisfaction gap analysis)	none, listing responses

Table 5.1 (Continued)

Agency	**Florida DOT**	**Delaware DOT**	**Maryland SHA**	**Atlanta MPO**
How is the data distributed within the agency?	Central & District offices prepare presentations, then present to representative or district office, statewide champion presents results to Executive Board and post on website	Websites and hardcopies	The results reported to Senior Management Team, Posted on Intranet, and District specific report generated and distributed to engineering district	Within division
Is the data used:		LRP	Business Plan, self-assessment, resource allocation	to evaluate how division works with partners
a. In goal setting for future years?	X	X	X	
b. In prioritizing existing projects?				
c. In justifying resources/need for new projects?			X	
d. To inform policy makers?	X			
e. To report to public?	X			
f. To measure/track performance?	X	X	X	
If yes to any of the above, which department manages this task?	Office of Policy Planning Director	Planning Department	Performance Excellence Division	Comp Planning/Transportation Planning Division
Are their formal procedures for the uses of Customer data identified in ques. 8?	Formal process, No written procedures	No	Yes, for agency self-assessment(every 3 yrs)	No

Table 5.1 (Continued)

Agency	**Florida DOT**	**Delaware DOT**	**Maryland SHA**	**Atlanta MPO**
What weighting is given to Customer satisfaction in ranking projects?	customers are the most important to FDOT, improvement areas are identified and statewide targets established	None yet	SHA interprets customer satisfaction as the opinion of end user, Capital project selection is based on input of key stakeholders in public forum (depending on county)	N/A
Is there a feedback loop to measure if selected priorities met customer data needs?	Yes	No	ratings over time will provide information about relative importance of certain functions and relative funding proportions	No
Is Customer Satisfaction a Measure of Effectiveness (MOE) for your agency?	Yes	No	Yes	informally as a division
a. If so, how do you measure it?			Customer Satisfaction Index, importance ratings are used to weight average performance ratings for 22 functions(Attributes). The weighting factor (WF) is calculated by dividing att mean importance rating by sum of all attribute importance ratings.	
b. Track it?	External Customer Satisfaction is a measure of the Department's Business Model			
In your professional opinion what is the importance of Customer satisfaction with respect to other transportation network MOEs?		N/A	Customer satisfaction is one important MOE, other MOEs include human resources safety, and budget	

The second iteration survey is presented in the same format as the first iteration but the Practitioners received this survey by email and completed online. The original survey instrument screen capture is presented as Figure B.2 in Appendix B

Table 5.2 Targeted Practitioner Survey Results (second iteration)

Agency	Minnesota DOT	Chicago MPO *	Puget Sound MPO	Washington DC MPO *
Do you collect customer survey data in addition to public involvement data for long-range plan?	Yes	Yes	Yes	Yes
How often do you collect data?	Annually, and for one-time market research efforts	As-needed	As-needed	Every 10 years (household travel survey)
What type of data is collected?		No response	No response	No response
a. Overall satisfaction ratings				
b. Individual attribute satisfaction ratings				
c. Performance ratings	X			
d. Attribute importance ratings	X			
e. Attribute satisfaction ratings				
How is the data distributed within the agency?				
How is the data used:	LRP, strategic planning	No response	Strategic Planning, Budgeting	Long-term planning
a. In goal setting for future years?	X		X	
b. In prioritizing existing projects?				
c. In justifying resources/need for new projects?			X	
d. To inform policy makers?				
e. To report to public?	X			
f. To measure/track performance?	X			

Table 5.2 (Continued)

Agency	Minnesota DOT	Chicago MPO *	Puget Sound MPO	Washington DC MPO *
If yes to any of the above, which department manages this task?	Office of Policy Analysis, Research and Innovation	Research and Analysis & Planning and Programming	Data Systems and Analysis	Transportation Department
Are their formal procedures for the uses of Customer data identified in ques. 8?	No	No	No	Yes, for data collection only
Is Customer Satisfaction a Measure of Effectiveness (MOE) for your agency?	Yes		No	No
In your professional opinion what is the importance of Customer satisfaction with respect to other transportation network MOEs?	Customer Satisfaction is at the core of overall priorities, and develop performance measures			

* data collected by telephone survey

5.3.2 Comparison of Processes

The literature review findings of how customer satisfaction can have dualistic characterization in performance measurement, namely as a core performance measure or one of several measures of importance, is exemplified by the variation in the response to the last question by Florida DOT, Minnesota DOT and Maryland SHA.

Most practitioners collected at least performance and importance ratings for specific attributes. How those attributes were selected varied. Florida DOT and Maryland SHA both used focus groups to identify service areas of interest and importance to their customer base.

Only Maryland SHA had formal written procedures for use of the customer satisfaction data in their self-assessment efforts every three years. Although all of the respondents in some way used customer data to inform the decision making process through goal setting, measure/tracking performance or reporting to the public and policy makers.

However the analysis methods performed on the customer data is primarily listing response frequencies and reporting changes over time. Maryland SHA has a more sophisticated Customer Satisfaction Index (CSI) measure that weights an individual performance rating by the overall importance proportion. This index gives a prioritization of performance by the attributes customers deem important. However, this analysis assumes an independent satisfaction performance relationship. This relationship is tested in the next task.

5.3.3 Documented Goals Review

This task drills one step further into the practitioner's customer satisfaction practices by identifying and comparing the presence of customer satisfaction goals and ideals in the planning products of the agency. Specifically, the long-range plan to ascertain if the vision, goals, and performance measures maintain the customer focus identified in the survey results. This task also looks closely at the documented performance measures to determine the validity of customer satisfaction measurement in practice. Table 5.3 lists the document review results for targeted practitioners.

The organization and inclusion of planning elements differs for each agency for example, Chicago MPO (CMAP) includes performance measures in the long range plan while Maryland SHA has a separate document for performance measures. Where possible the separate monitoring and performance document was also reviewed for customer satisfaction elements. Below are some of the key findings from the review.

- Many agencies refer to 'Quality of Life' issues in their vision, goals, and/or performance measures but the definition is unclear.
- Vision statements were not always clearly identified or separate from overall goals.
- Some visions were detailed and descriptive, while others were general and overarching.
- The types of goals used varied, both outcome and output goals were present.
- The number of goals varied from CMAP's three to Minnesota DOT's ten.

Table 5.3 Targeted Practitioner Document Review Results.

Implementing Agency	Document Name (dated)	Planning time period	Coverage area	Vision
Minnesota DOT	Minnesota Statewide Transportation Policy Plan (8/2009) Vision date **2028**	20yrs	Statewide	A Safe, Efficient and Sustainable Transportation System
Florida DOT	Moving Together 2025 Florida Transportation Plan (12/2005) Vision date **2025**	20yrs	Statewide	A competitive economy, livable communities and a sustainable environment will require a world-class transportation system
Delaware DOT	Planning Together Moving Ahead (9/2002) Vision date **2025**	20yrs	Statewide	Mission: To provide a safe, efficient, and environmentally-sensitive transportation network that offers convenient, cost-effective mobility opportunities for people and goods.
Maryland SHA	2009 Maryland Transportation Plan (10/2007) Vision date **2035**	20 years	Statewide	A world-class multimodal transportation system that supports a vibrant economy and an excellent quality of life for all Marylanders.
Atlanta MPO	Envision 6 Planning for a region of 6 million (9/2007) Vision date **2030**	25 yrs	Atlanta Region -	

Table 5.3 (continued)

Implementing Agency	Document Name (dated)	Planning time period	Coverage area	Vision
Puget Sound MPO	Destination 2030 Update (4/2007) Vision date **2030**	30 years	Central Puget sound region - King, Pierce, Snohomish, and Kitsap Counties of Washington State	-Destination 2030 is about making traffic better, keeping pace with growth and supporting the region's economic and environmental health. – At the core of the vision is the growth management strategy of supporting compact urban areas connected by high-capacity transportation that creates additional transportation and housing choices for everyone in the region.
Chicago MPO	Updated 2030 regional transportation Plan for Northeasters Illinois (10/2008) Vision date **2030**		Chicago region – Cook, DuPage, Kane, Kendall, Lake, McHenry and Will counties of Illinois State	-This Regional Transportation Plan (RTP) provides public policy direction and guidance for the continued development of a safe, efficient multimodal surface transportation system in northeastern Illinois -Intent: Promote efficient travel behavior and accommodate it and Promote an efficient urban economy and sustain it.

Table 5.3 (continued)

Implementing Agency	Document Name (dated)	Planning time period	Coverage area	Vision
Washington D.C. MPO	National Capital Region Transportation Planning Board Financially Constrained Long-Range Transportation Plan (11/2008) Vision date **2030**		Washington DC region – Frederick, Montgomery, Loudoun, Fairfax, Prince George's, & Prince William Counties, Falls Church, Arlington, Alexandria, Fairfax city, Manassas, & Manassas Park Cities and St. Charles urbanized area, in Virginia, Maryland and District of Columbia. (the 1983 census MSA)	In the 21st Century, the Washington metropolitan region remains a vibrant world capital, with a transportation system that provides efficient movement of people and goods. This system promotes the region's economy and environmental quality, and operates in an attractive and safe setting–it is a system that serves everyone. The system is fiscally sustainable, promotes areas of concentrated growth, manages both demand and capacity, employs the best technology, and joins rail, roadway, bus, air, water, pedestrian and bicycle facilities into a fully interconnected network.

Table 5.3 (continued)

Implementing Agency	Goals	Monitoring/ Performance document	Customer Satisfaction Performance Measure?
Minnesota DOT	1- Traveler Safety 2- Infrastructure Preservation 3- Maintenance and Security 4- National and Global Connections 5 – Statewide Connections 6- Twin Cities Mobility 7- Greater Minneapolis Metropolitan and Regional Mobility 8- Community Development and Transportation 9- Energy and the Environment 10- Accountability and Transparency	Scorecard for 13 Performance Measures	Use data from Omnibus Survey for Customer Satisfaction with reliability of MN/DOT communication.
Florida DOT	1- A safer and more secure transportation system for residents, businesses and visitors 2- Enriched quality of life and responsible environmental stewardship 3- Adequate and cost-efficient maintenance and preservation of transportation assets 4 – A stronger economy through enhanced mobility for people and freight 5 – Sustainable transportation investments for Florida's future	2009 Performance Report	
Delaware DOT	1- Development 2- Travel Opportunities and Choices 3- Cost-Effectiveness 4- Quality of Life 5- Economic Development and Growth 6- Planning and Coordination	State of the System report (future)	No
Maryland SHA	1- Quality of Service 2- Safety & Security 3- System Preservation & Performance 4- Environmental Stewardship 5- Statewide Connections 6- Twin Cities Mobility 7- Greater Minneapolis Metropolitan and Regional Mobility 8- Community Development and Transportation 9- Energy and the Environment 10- Accountability and Transparency	2009 Maryland Attainment Report	CSI index

Table 5.3 (continued)

Implementing Agency	Goals	Monitoring/ Performance document	Customer Satisfaction Performance Measure?
Atlanta MPO	1- Improve accessibility and mobility for all people and freight 2- Encourage and promote the safety, security and efficient development, management, and operation of the surface transportation system 3- Protect and improve the environment and the quality of life 4- Support economic growth and development	N/A	none
Puget Sound MPO	1- Support maintenance and preservation of existing transportation infrastructure and services as a high priority 2- Provide stronger links between the transportation system and land use development to encourage growth within defined urban growth areas with balanced investments in multimodal transportation improvements 3- Identify and prioritize projects, programs and policies to improve all modes of transportation and keep up with growth 4- Improve the region's financial capacity to fund needed investments 5 - Tailor recommendations at the sub-regional and corridor levels, in recognition of the region's social, physical and cultural diversity		No C.S. Performance Measure
Chicago MPO	1 - Maintain the integrity of the existing transportation system 2 - Improve transportation system performance 3- Employ transportation to sustain the region's vision and values*	N/A	Customer satisfaction performance as measured improvement on customer surveys

Table 5.3 (continued)

Implementing Agency	Goals	Monitoring/ Performance document	Customer Satisfaction Performance Measure?
Washington D.C. MPO	1- The Washington metropolitan region's transportation system will provide reasonable access at reasonable cost to everyone in the region. 2- The Washington metropolitan region will develop, implement, and maintain an interconnected transportation system that enhances quality of life and promotes a strong and growing economy throughout the entire region, including a healthy regional core and dynamic regional activity centers with a mix of jobs, housing and services in a walkable environment. 3 - The Washington metropolitan region's transportation system will give priority to management, performance, maintenance and safety of all modes and facilities. 4- The Washington metropolitan region will use the best available technology to maximize system effectiveness. 5- The Washington metropolitan region will plan and develop a transportation system that enhances and protects the region's resources, and communities. 6- The Washington metropolitan region will achieve better inter-jurisdictional coordination of transportation and land use planning. 7- The Washington metropolitan region will achieve an enhanced funding mechanism(s) for regional and local transportation system priorities that cannot be implemented with current and forecasted federal, state, and local funding. 8 - The Washington metropolitan region will support options for international and interregional travel and commerce.	N/A	

- The multimodal policy plan identifies the vision for all modal agencies while the DOT LRP is a specifically how the DOT plans to address the policy plan. Both documents were consulted to populate the table since some of the goals may be outside the purview of DOT but within the goal of broadened planning goals.

- Some agencies use terms like transparency (Minnesota DOT) and values (CMAP) in their goals which show a shift in focus from providing products like asphalt and bridges to maintaining services and quality of those services.
- Two agencies (Minnesota DOT and CMAP) explicitly identified customer satisfaction performance measures
- The customer satisfaction performance measures are identified as being based on survey responses.
- Minnesota identified level of satisfaction with communication reliability as a metric for customer satisfaction, they also identified new measures are being developed.
- Many of the planning products did not include the customer satisfaction products available within their agency. For example, Maryland SHA has a robust customer satisfaction program that is not mentioned in their LRP.

5.3.4 Summary of Practitioner Review

This task identified a target group of transportation practitioners that are active and pioneering in the usage of customer satisfaction, conducted a survey of those targeted practitioner agencies and reviewed their planning products for cohesion regarding customer satisfaction. The type of analysis conducted varies greatly from agency to agency and the planning products do not always reference the extensive customer satisfaction efforts of the practitioner agency. Quality of life is a buzzword used in nearly all of the planning documents but the understanding and definition similar to customer satisfaction is not standard or even provided in some instances.

5.4 Asymmetrical Nonlinear Concept Test

5.4.1 Introduction

This section tests the implicit linear symmetric assumption of satisfaction and performance with real-world data in a case-study example. The analysis assumptions, data requirements and methods are identified. The objective is to apply the theoretical methodology, outlined in chapter 4, in a transportation context. The customer satisfaction framework discussed in chapter 3 utilizes the findings of this concept test to offer analytical processes for integrating customer satisfaction in the transportation decision making process. This section is an empirical application of the methodology using product-based research findings on transportation data.

5.4.2 Source Data (Data Schema)

This research uses the National Cooperative Highway Research Program 3-70 (NCHRP, 2008), Multimodal Level of Service Analysis for Urban Streets data collected in 2006 and made available through the Quality of Service Subcommittee/Taskforce of the Transportation Research Board HCQS committee. This prior research is described in detail here to highlight the divergent assumptions and intended applications of the data. This data is used later to test the concept of asymmetrical nonlinear satisfaction-performance relationship for an empirical customer satisfaction methodology for integration in transportation decision making.

5.4.2.1 Purpose

The NCHRP 3-70, Multimodal Level of Service Analysis for Urban Streets project collected customer perceived level of service (LOS) ratings from drivers in four diverse geographical locations, using video laboratories of four modes; auto, transit, bike and pedestrian. “The objective of the project was to develop and test a framework and enhanced methods for determining levels of service for four modes on urban streets, in particular with respect to the interaction among the modes.” (NCHRP, 2008) The NCHRP 3-70 project is part of a larger project to update the Highway Capacity Manual for 2010. The NCHRP 3-70 effort was a multi phased project undertaken over 2 years with a $1.1 million dollar budget. This dissertation research is leveraging the extensive resources invested in “a data collection plan to better measure the traveling public’s perception of quality of service on urban streets”. The NCHRP study is the first endeavor of this magnitude to measure customer’s perceptions in the surface transportation context.

5.4.2.2 Methodology

The source data collected field survey data for four modes (auto, transit, bicycle and pedestrian) however this research is primarily interested in the data for the automobile mode. The data was collected using a video laboratory methodology; this was selected because of the ability to expose single subjects to multiple conditions, even though fewer subjects were used.

Creating Video Clips

The preliminary phase of data collection refined 42 Quality of Service factors (Table 5.4) influencing traveler's perception, determined in SAIC research (SAIC, 2003), as a basis for key factors to measure in data collection phase. The key factors from Phase I were

Table. 5.4 Driver Identified QOS Factors For Urban Streets

Investment Area	**QOS Factor**	
Cross-Section Roadway Design	Lane width Pedestrian/bicyclist facilities # of lanes/roadway width Bus pull-outs Turning lanes/bays	Parking Lane drop/add Access management Medians Two-way center left turn lane
Arterial Operations	Number of traffic signals Presence of large vehicles Volume/congestion	Travel time Traffic flow Speed
Intersection Operations	Signal failure/inefficient signal timing Turning	Timing of signals Traffic progression
Signs and Markings	Quality of pavement markings Advance signing Lane guidance—signs Too many signs	Lane guidance—pavement markings Sign legibility/visibility Sign presence/usefulness
Maintenance	Pavement quality	Overgrown foliage
Aesthetics	Presence of trees Medians with trees Visual clutter	Cleanliness Roadside development
Other Road Users	Illegal maneuvers Careless/inattentive driving Driver courtesy Use of turn signals	Aggressive drivers Pedestrian behavior Improper/careless lane use Blocking intersection
Other	Intelligent transportation systems	Roadway lighting Planning

used to select and create video clips to be used in Phase II, the pilot study helped determine impacts of the selected data collection methodology (video lab), refine presentation and process of clips and eliminate spuriously correlated attributes.

The video clips were created by George Mason University in summer/fall of 2005 for data collection in the summer 2006. Using the top four influential factors, to vary clip characteristics and attributes, determined by the design team:

1. Presence of median (yes/no),
2. Landscaping (yes/no),
3. Progression (no progression is stopped at over 50% of signals), and
4. Posted speed (surrogate for arterial type).

The team created clips with relatively consistent cross-section (i.e. road width, sidewalk conditions etc.) to provide consistent feel throughout the video. The videos were then edited, complied and format for survey presentation into ½ mile segments. The video clips were presented from the driver's point of view with a speedometer inset screen. All videos were recorded in daytime clear conditions on arterials in Metro Washington DC.

Administering surveys

Survey participants rated the quality of service displayed in each video clip on a six (6) point scale "A" to "F", with "A" being the best and "F" being the worst. They rated a total of ten (10) video clips recording their perceived LOS after each video viewing. Six (6) video clips were randomly selected for each geographical region with four (4) standard clips shown in each region to measure for regional bias. The design team also randomized the sequence of clips shown in each region to minimize the likelihood of respondent fatigue biasing the results (Table 5.5). Prior to data collection a pilot video

Table 5.5 Automobile Clip Sequencing at Testing Locations

Presentation Order	**Location of Video Laboratory – Auto Clips Shown**			
	New Haven, CT	Chicago, IL	Oakland, CA	College Station, TX
Pilot Clip	25	25	25	25
1	21	20	12	15
2	55	56	56	7
3	52	10	8	52
4	60	51	65	13
5	53	14	59	58
6	56	2	29	56
7	54	62	6	2
8	2	63	15	1
9	15	52	2	61
10	57	15	52	64
Total Clip Time				

clip was shown at each location to orientate the participants to the process, and a focus group discussion was conducted after all clips were viewed and rated to allow feedback from participants and to provide a $75 cash honorarium. The respondents were asked to assume a time constrained commuter condition when rating. The project collected data from four geographical regions varying in population size and climate(San Francisco, CA; College Station, TX; Chicago, IL; and New Haven, CT) with a range of 30-40 participants in each region, for a maximum total of 139 data points (unique respondent ratings) for each video clip.

Recruitment/Sampling/Administrative

The NCHRP study recruitment was based on age, gender and regular users of modes other than automobile; Table 5.6 shows the characteristics of participants. The study under sampled single family residents and over sampled people over 60, but aligned the sample to national average for gender and vehicle availability.

Table 5.6. Characteristics of Participants

Age Group (years of age)	New Haven, CT		Chicago, IL		San Francisco, CA		College Station, TX		Total
	Male	Female	Male	Female	Male	Female	Male	Female	
Young (18-35)	2	4	4	4	6	12	3	5	40
Middle (36-50)	9	8	9	6	9	8	8	6	63
Older (60+)	2	9	6	6	1	2	6	10	42
Total	13	21	19	16	16	22	17	21	145

5.4.2.3 Coding

The video clips rated vary in a number of their performance attributes. Some of these attributes are binary meaning they are present or not present. The design team determined various levels for these attributes to distinguish between perceptible performance levels, for instance the presence of trees is a yes or no attribute however some arterials may be heavily wooded versus one tree over the half mile segment, but according to the presence of trees attribute they would be coded the same. Therefore the binary attributes were subcategorized into multiple level dummy attributes to account for these instances. Table 5.7 lists the automobile performance attributes measured and recorded for each video clip.

Table 5.7 Video clip attributes

Clip #
Clip Distance (miles)
Street Name
HCM Class
LOS
Number of Through Lanes *
Presence of Median **
Total Travel Time (seconds) *
Space Mean Speed *
Average Spot Mean Speed (MPH)
Variance of Speed
Lane Position
PED on sidewalk **
Pavement Quality **
Number of Stops (below 5 mph) *
Total Number of Signals *
Stops/Signal
Presence of Exclusive. Left Turn Lane – Signals **
Presence Of Right Turn Lane – Signals **
Quality of Lane markings **
Sign Quality **
Landscaping **
Tree Presence **
Vehicle
Vehicle Driver
Position in queue at red lights
Estimated Control Delay By Signal
Dummy Variable – Median **
Dummy Variable - Pavement Quality **
Dummy Variable - Lane Marking Quality **
Dummy Variable -Sign Quality **
Dummy Variable - Landscape Quality **
Dummy Variable - Presence of Trees **

* - attribute selected for analysis
** Variable levels determined by Research team

5.4.2.4 Findings

The major departure between the source data objectives and this research is the intention of NCHRP 3-70 to develop a traveler perception element into the design evaluation process. While this research intends to develop a perception based satisfaction methodology to evaluate project, enhancements etc at the decision making level. However the source data findings validate customer ratings of LOS to the methodological LOS calculations and identify primary attribute determinants, which is valuable to the current research application. In order to create a model of LOS based upon customer perception the NCHRP 3-70 research team converted the distribution of the measured LOS to a single LOS grade for given clip, using a compressed range of thresholds to convert the distribution to a mean value that could range from LOS A to LOS F. Then, developed an Auto LOS model that estimates the mean clip rating only using seven explanatory variables to control redundancy and capture highly correlated attributes. The seven variables are: 1- Space mean speed, 2- Number of stops, 3- Stops per mile, 4- Presence of median, 5 - Presence of exclusive left turn lane, 6 - Presence of trees rating, and 7 - Pavement quality rating. Multiple linear regression models were created and validated however, a cumulative logistic regression model approach was determined to be more accurate due to linear regression models prediction of a continuous variable. The NCHRP study recommends two models of the same form because Model #1 (Stops per mile and Presence of exclusive left turn lane) has superior statistically significant fit to test data but does not produce LOS A estimates. While the recommended model, Model #2 (Percent of free-flow speed and Type of median), is a speed-based option and can produce the full range of LOS ratings. Both adequately estimate the distribution of LOS found in the data collection phase. Anecdotally each of the models predicted the observed LOS ratings better than the traditional HCM LOS methodology (Table 5.8).

Table 5.8 Correlation Coefficients of Auto LOS Models

Models Compared	**Pearson Correlation Coefficient**
HCM LOS to Mean Observed LOS	0.465
Mean Observed LOS to Mean LOS-– Model 4	0.787
Mean Observed LOS to Mean LOS – Model 5	0.764
Mean Observed LOS to Mean LOS – Model 6	0.770

Ultimately, the NCHRP study is interested in determining an integrated multimodal LOS methodology. The four modes report individual LOS rather than a comprehensive LOS, modal LOS is defined as the average degree of satisfaction if traveler travels full length of study section of street. The new methodologies created in the NCHRP 3-70 study will be incorporated into the HCM 2010 version.

5.4.3 Research Data Schema

The data from the NCHRP-3-70 described above was used to test the hypothesis that the impact of positive performance is different than the impact of negative performance on customer satisfaction, which indicates a nonlinear asymmetrical relationship. This data was selected because of its customer perception ratings, the variety of customers surveyed throughout the country and the use of base Quality of Service attributes.

5.4.3.1 Data assumptions

The theoretical methodology used in product based industry (Anderson, 2000) and identified in Chapter 4 has discrepancies with the experimental design of the NCHRP 3-70 (NCHRP, 2008) study, which necessitates data manipulations and assumptions shown on Table 5.9. First, the Level of Service ratings collected as part of the NCHRP 3-70

Table. 5.9 Data Assumptions

Desired Data	Actual Data	Assumption	Level of impact
Customer Satisfaction rating	Level of Service rating	LOS is proxy of Satisfaction	Minor
Expectation of performance	Measured Attribute performance	Measurement includes expectation	Minor
Attribute Performance rating	Measured Attribute performance	Measured levels are equivalent to ratings	Major, cannot subdivide performance into meets, exceeds, or does not meet expectation
Representative sample	Less than national average for age and residential type	Will not impact results severely, exploratory research to identify patterns	Moderate
Completely generalizable	Spatial, demographic & temporal dependence	Spatial – ratings collected by regions Demographic – careful sampling to reduce bias (see representative sample) Temporal – ratings are snapshot in time (same as lagging measure)	Minor
Actual preference	Stated preference	Respondents rate as they would at time of choice behavior	Minor
Leading measure (predictable)	Lagging measure	Ratings are a snapshot in time	Minor

study is an adequate proxy for customer satisfaction ratings, since both are based on perception and rates the service. Secondly, the performance of attributes was measured but not rated by the survey respondents as part of the source data study. This is a major limitation because the theoretical methodology assumes the performance to be a perception based measure same as satisfaction ratings. However for this exploratory research using measured values will limit the conclusiveness of the findings but can indicate the type of relationship between attribute performance and customer satisfaction. Next, the sample is not representative of the population in age and residential type. The source data study sampling goals were specific to the intention of the data and that is to develop a multimodal LOS model, specifically capturing users of multiple modes. For the current research a broader sample of customers is acceptable since there is only one mode under investigation. However, revised and refined experimental design will provide greater explanatory power to the conclusions of this research.

In addition to methodological assumptions general conceptual assumptions regarding the nature of customer satisfaction are necessary to devise an empirical analysis of a predominately cognitive activity. Customer satisfaction is a lagging measure, meaning you can only measure satisfaction 'after' the experience. This research has accounted for the lagging nature of customer satisfaction by assuming the rating is a snapshot in time. A similar approach is used in the Pavement Serviceability Index (PSI) (Carey, 1960), which uses perceived smoothness of pavements by an expert panel to be a snapshot of the pavement quality at the time of the determination even though various experts may rate quality variably and the quality will change over time depending on external factors. Other challenges of the data are that the data is collected in a stated preference format. It is also spatially, demographically and temporally dependant, which means that the location, socioeconomic and time of surveys may impact the responses. The source data experimental design accounts for these limitations by varying the geographical location, order of clips and the socioeconomic characteristics of the respondents. However, survey fatigue and repeat observations may introduce bias. Many of these assumptions and challenges can be addressed through careful experimental design of future data collection applications.

5.4.3.2 Selection of attributes

The first step is to determine which subset of attributes to use for the analysis. The full set of attributes (Table 5.7) used in the source research is refined further to meet three criteria: 1) observable, 2) tangible, and 3) actionable. The five attributes selected are:

1 – Number of Stops,
2 - Number of Through Lanes,
3 – Number of Signals,
4 – Space Mean Speed, and
5 – Total Travel Time

Since this research is exploratory the most rudimentary attribute was selected to determine the pure relationship between performance and satisfaction. For example, the stops/signal attribute combines two of the selected attributes but does not meet all of the criteria. Specifically, the observable criterion, since drivers do not do a conversion during their trip, and the actionable criterion since decision makers would have to manipulate a ratio of attributes. Likewise attributes that are binary were excluded (i.e. presence of exclusive left turn lane) since the performance value is either yes or no their performance would not have a distribution therefore determining the impact to satisfaction could be difficult to determine. The dummy variables created in the NCHRP study to create a distribution for the binary attributes were not used because the levels of performance and subdivision of levels was determined by the research team after data collection. Appendix D tabulates all of the measured performance values for the selected attributes.

5.4.3.3 Descriptive statistics

Table 5.10 lists a sample of descriptive statistics for three video clips. This data is required to determine the distribution of each clip. This knowledge will assist in identifying relevant statistical applications and tests. The median mode and standard

Table 5.10 Sample Statistics for Video clips

Clip 2		*Clip 15*		*Clip 52*	
Mean	4.835	Mean	4.230	Mean	3.655
Standard Error	0.092	Standard Error	0.116	Standard Error	0.113
Median	5	Median	4	Median	4
Mode	5	Mode	5	Mode	4
Standard Deviation	1.081	Standard Deviation	1.369	Standard Deviation	1.328
Sample Variance	1.168	Sample Variance	1.874	Sample Variance	1.764
Kurtosis	1.870	Kurtosis	-0.317	Kurtosis	-0.596
Skewness	-1.202	Skewness	-0.563	Skewness	-0.283
Range	5	Range	5	Range	5
Minimum	1	Minimum	1	Minimum	1
Maximum	6	Maximum	6	Maximum	6
Sum	672	Sum	588	Sum	508
Count	139	Count	139	Count	139

deviations of the video clip satisfaction ratings indicate the data set is relatively homogenous. Meaning there are few ratings that account for the bulk of responses.

However, the full range of ratings was observed for each video clip. Where the dependant variable is customer satisfaction and the explanatory variable(s) is attribute performance. Figure 5.3 illustrates this observation for the total travel time attribute.

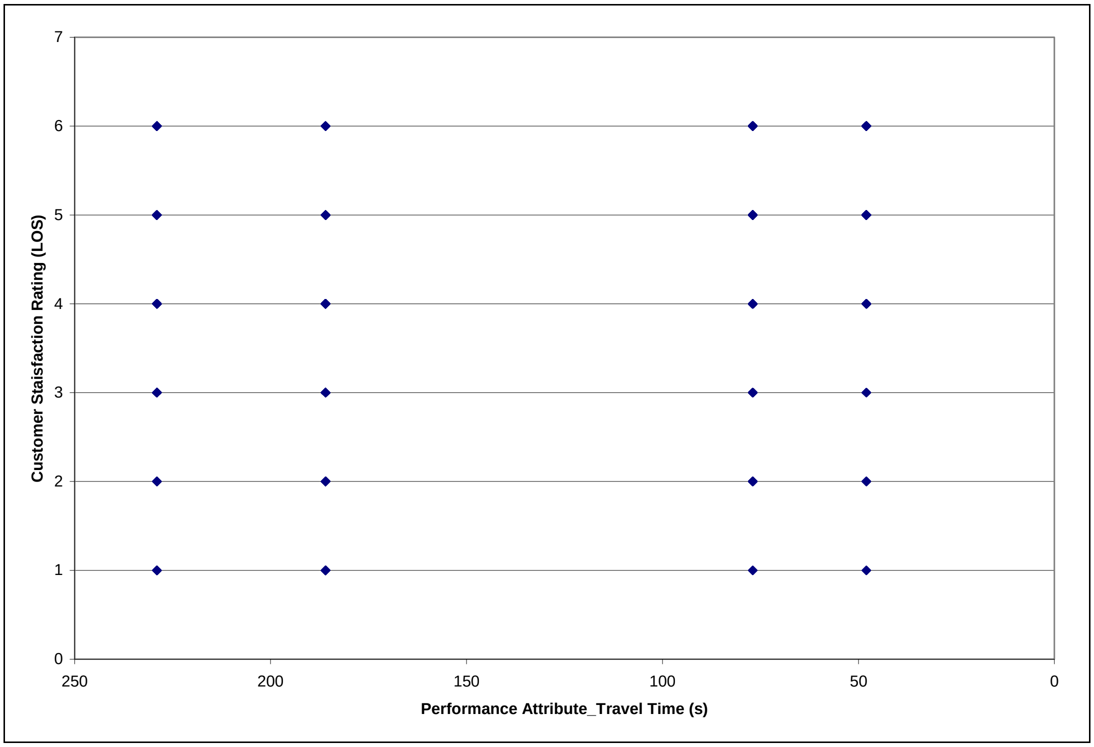

Figure 5.3 Performance Satisfaction Plot

Although most respondents rated a clip within one level, each level is present in the data as can be evidenced by the graph.

Data Organization

The experimental design of the Source data is such that the results (customer satisfaction ratings of video clips) can be grouped in multiple formats. The number of respondents varies for the four clips shown in each region, and by region (Table 5.11).

There are multiple ways to organize the data: 1) all data together, 2) by region, and 3) four standard video clips separate from other clips. The third approach effectively creates a fifth region, with four times as many data points and no regional bias. Each of these organization methods could yield different analysis results. Therefore it is important to note which data organization is being used and how that impacts results. This case-study presents data in each format and identifies which format is being used. If major discrepancies or nuanced interpretation variance occurs it is mentioned in this case-study.

Table 5.11 Number of respondents per video clip

Region	Video Clip	Number of raters
ALL	2	139
	15	139
	52	139
	56	139
Region 1	21	30
	55	30
	60	30
	53	30
	54	30
	57	30
Region 2	20	35
	10	35
	51	35
	14	35
	62	35
	63	35
Region 3	12	36
	8	36
	65	36
	59	36
	29	36
	6	36
Region 4	7	38
	13	38
	58	38
	1	38
	61	38
	64	38

Graphical relationship

The next step in determining the distribution of data in order to select appropriate statistical tests is to plot the frequency of customer satisfaction ratings. (Figure 5.4). A

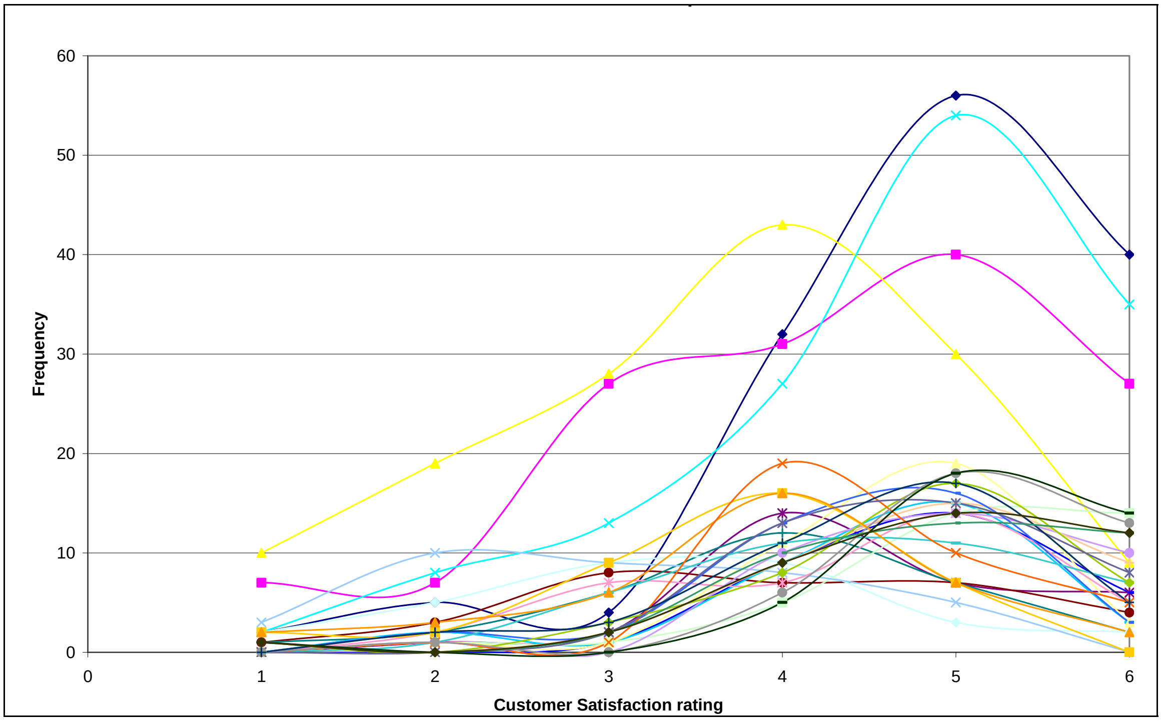

Figure5.4. Customer satisfaction Rating Distributions

graph of the distribution of ratings will visually identify if the clips are parametric or nonparametric. From Figure 5.4 and Table 5.10, it is apparent that the customer satisfaction ratings are nonparametric since the shape of rating distributions does not follow the Normal distribution curve and the dispersion of the data does not meet the requirements of a Normal distribution. This requires that nonparametric statistical methods be used.

Independence and Correlation

The data used for this research was collected in a repeated sample format where a group of customers rated ten random samples of video clips. This data collection method requires that we test the responses for independence of rater as well as correlations across groups. For example, one person in region 3 may rate each of the clips at low LOS, testing for independence of raters will identify if the clips themselves are the reason for low LOS or if it's the rater that influences the relationship of low LOS ratings. Table 5.12 lists a selection of Spearman's Rho correlation coefficients for the ALL Regions data.

Table 5.12 Spearman's Rho Correlation Coefficients across clips

Correlation Coefficient	Clip 2	Clip 15	Clip 52	Clip 56
Clip 2	1			
Clip 15	-0.2722	1		
Clip 52	-0.4362	-0.3625	1	
Clip 56	-0.2693	-0.5232	-0.1191	1

In this instance we used the Spearman's Rho Correlation coefficient because the data is categorical. (see Appendix E for all correlation coefficients).

Since the data has k-related samples Friedman's test of significance is used to generalize sample patterns to the larger population and determine statistical significance of the correlation. Where H_0: No difference in video clip ratings. Using ranks, since the data is ordinal, we reject the null hypothesis (Table 5.13). This means the likelihood

Table 5.13 Friedman Test of Independence

Friedman Test Stat	df	P-value	Reject Null
54.79	3	.95	Yes

that the patterns in the data are due to sampling error are less than 5 in 100 cases, or that there is a difference in the ratings of the video clips. This means that the independence of ratings is statistically significant, or that the video clips ratings are different. (see Appendix F for all Friedman tests)

Regression Analysis

Now that we have identified that there is a statistically significant difference in video clip ratings we look to explain and quantify potential reasons for that difference. The next step in the analysis is to measure the impacts of both high and low performance on the rating of customer satisfaction. The hypothesis is the difference is due to an asymmetrical nonlinear relationship between customer satisfaction and attribute performance. We test this by conducting linear regression analyses.

First, a traditional linear regression with combined high and low performance attributes gives a baseline to compare the divided results. Then, recode data for dummy regression by separating high and low performance ratings. This can be accomplished by first transforming the data or inserting a function that enters a 1 or 0 if attribute performance is high (or low). In order to separate the high and low performance a break point of attribute performance must be defined. Since the data is measured not rated the attribute mean is used as the high/low break point. Table 5.14 illustrates this division of

Table 5.14 Example high/low separation data table (mean = 2.14)

Video Clip performance	Satisfaction rating	Lo Perf	High Perf
2	4	1	0
2	6	1	0
2	6	1	0
2	3	1	0
2	5	1	0
3	5	0	1
3	5	0	1
3	1	0	1
3	6	0	1
3	4	0	1

customer satisfaction ratings by the attribute performance level (high/low) and the dummy variable 0 or 1 that is substitute for the attribute.

Next conduct a dummy regression analysis of low performance attributes, then of high performance attributes noting the regression coefficients, R-square value, F-test and significance of F (Table 5.15) to compare to normal regression results.

Table 5.15 Comparison of Regular, High and Low performance regression results

	Regression (regular)			High performance regression coefficients			Low performance regression coefficients		
Performance Attributes	coeff.	F (sig. F)	R^2	coeff.	F (sig. F)	R^2	coeff.	F (sig. F)	R^2
Through Lanes	-0.065	0.996 (.319)	0.001	0.014	0.30 (.582)	0.000	-0.004	2.02 (.156)	0.001
Total Travel Time	-0.006	121.61 (.000)	0.081	0.007	67.10 (.000)	0.046	-0.004	116.28 (.000)	0.077
Number of Stops	-0.327	149.92 (.000)	0.097	0.261	14.55 (.000)	0.010	-0.261	134.40 (.000)	0.088
Number of Signals	-0.171	100.58 (.000)	0.068	0.183	41.40 (.000)	0.029	-0.125	102.68 (.000)	0.069
SMS	0.034	110.65 (.000)	0.074	0.020	85.41 (.000)	0.058	-0.025	26.23 (.000)	0.019

The regression analysis shows that there is a difference in normal regression results as well as between high performance and low performance. A graphical representation of the results will be discussion in the next section. However, Table 5.15 shows that all the attributes reject the null hypothesis of H_0=0, except for the number of through lanes attribute. The R-square values are very low for all regression analysis. This indicates that the model fit is poor. The poor model fit is not desirable but the purpose of this analysis is testing the implicit linear assumption, the poor fit of the *linear* regression model additionally supports the hypothesis. Other models that approximate nonlinear relationships could have been used but the complexity of conducting the analysis and interpreting their results could not match the simplicity and familiarity of linear regression models. Since the application of the resultant framework will be used by both technical and non-technical personnel the simplicity of analysis was prioritized over model fit.

5.4.3.4 Determining nature of attribute

Determining if the relationship of performance and satisfaction is asymmetrical and nonlinear is essential to effective resource allocation. It is also important to know the nature of attribute to select appropriate actions to maintain or enhance satisfaction. From chapter 2, a satisfaction enhancing (SE) attribute is one where the impact of high performance has a greater impact (steeper slope) than negative performance; it is also considered a novel or excitation factor. While a performance factor (PF) attribute has equal impact from high and low performance, this indicates a linear relationship between performance and satisfaction. And lastly, a satisfaction maintaining (SM) attribute is the expected price of doing business attribute that has a steeper slope and greater impact on satisfaction in the low performance area. A relative impact graph gives a visual identification of which performance level (high or low) has the strongest impact and the direction of that impact. This information is used to determine the nature of the attribute.

5.4.3.5 Relative impact graph

This study utilizes a relative magnitude bar graph, or relative impact graph, which provides a visual indicator of the impacts to satisfaction plotting the magnitude of the dummy regression coefficients. The value of the coefficient explains the relative impact and the direction (+/-) explain the relationship of performance to the attribute (inverse or direct). In this graphic the high performance to the right of the zero line indicates that high performance positively impacts customer satisfaction. However there could be instances where both positive and negative performing attributes positively impact customer satisfaction and this would be represented by a bar only to the right of the zero line. This is possible for extreme SE attributes that may be new services that although the performance is not high the existence of the service improves the customers satisfaction. The value of the coefficient alone does not tell the story of the attribute relationship but the relative value of high to low performance value. A larger high performance value indicates a SE attribute while a larger low performance value indicates a SM attribute. This means that the larger magnitude has a greater impact on the customer satisfaction determination. In the case where both low and high performance have equal impacts this indicates a linear relationship.

Translating the data from Table 5.15 into a graphical representation we create Figure 5.5. This graph indicates there are three satisfaction enhancing (SE) attributes: number of signals, total travel time and number of through lanes. While the space mean speed and number of stops attributes show an equal impact for both positive and negative performance which indicates a linear and symmetric relationship or performance factor (PF) attribute.

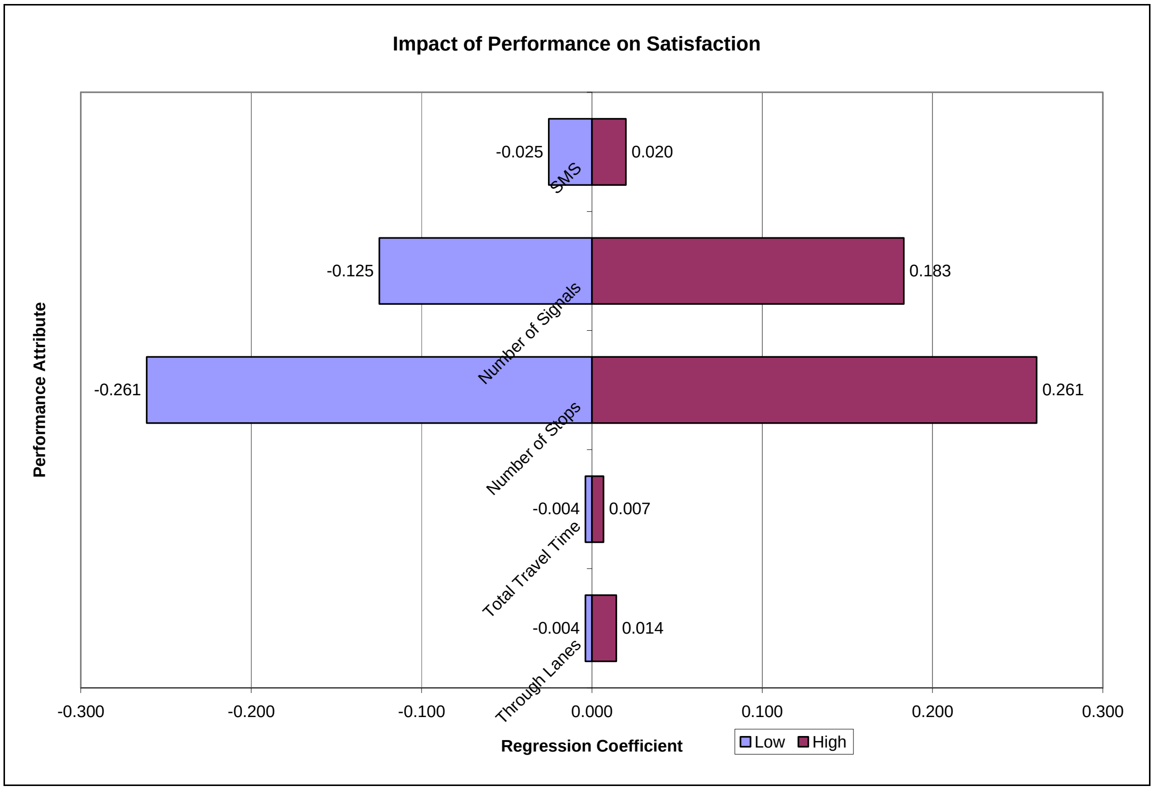

Figure 5.5 Impact of high and low performance on satisfaction

The number of through lanes attribute is considered satisfaction enhancing (SE) because the relative magnitude of impact of high performance to low performance is greater. Meaning the high performance values, more through lanes, generate more satisfaction at a greater rate than low performance values, fewer through lanes.

From table 5.15 the regression coefficient for number of through lanes when both high and low performance are taken together is -.065, while the separate dummy regression results for high performance (0.014) and low performance (-.004) differ. Interpreting the normal regression analysis would conclude that the number of through lanes inversely impacts satisfaction, meaning the fewer lanes the greater satisfaction. While the nonlinear asymmetric analysis indicates that the number of through lanes is impacted more so by high performance, meaning the more through lanes the greater influence on satisfaction. This discrepancy can have resource allocation impacts.

5.4.3.6 Disaggregate relative impact graphs by region

Since many transportation resource allocation decisions are made at the regional level, it is valuable to investigate the customer satisfaction relationship to performance at that level. Using the same methodology as before, we reorganize the data by region and conduct a dummy variable regression the results are listed in Table 5.16, and graphically

Table 5.16 Regression Results by region

By Region	Low	High	N	mean perf	mean sat rating	high perf if x	
Through Lanes	-0.004	0.014	1390	2.2	4.42	x > 2.14	ALL regions
Total travel time	-0.004	0.007	1390	120.5	4.42	x < 115	
# of stops	-0.261	0.261	1390	1.49	4.42	x < 1.4	
SMS	-0.025	0.02	1390	19.2	4.42	x > 19.54	
# of signals	-0.125	0.183	1390	3.1	4.42	x < 3	
Through Lanes	0.144	-0.096	300	2.1	4.09	x > 2.14	Region 1
Total Travel Time	-0.004	0.007	300	122	4.09	x < 115	
# of stops	-0.176	0.317	300	1.6	4.09	x < 1.4	
SMS	-0.021	0.018	300	18.2	4.09	x > 19.54	
# of signals	-0.067	0.041	300	2.9	4.09	x < 3	
Through Lanes	-0.026	0.007	350	2.2	4.51	x > 2.14	Region 2
Total Travel Time	-0.005	0.009	350	128	4.51	x < 115	
# of stops	-0.39	0.846	350	1.7	4.51	x < 1.4	
SMS	-0.021	0.022	350	20.3	4.51	x > 19.54	
# of signals	-0.19	0.338	350	3.5	4.51	x < 3	

(Table 5.16 continued)

Through Lanes	0.226	-0.15	360	2.2	4.34	x > 2.14	Region 3
Total Travel Time	-0.003	0.005	360	119	4.35	x < 115	
# of stops	-0.203	0.139	360	1.6	4.35	x < 1.4	
SMS	-0.019	0.016	360	19	4.35	x > 19.54	
# of signals	-0.05	0.016	360	3.1	4.35	x < 3	
Through Lanes	-0.189	0.086	380	2.2	4.66	x > 2.14	Region 4
Total Travel Time	-0.002	0.004	380	114.3	4.66	x < 115	
# of stops	-0.193	-0.037	380	1.1	4.66	x < 1.4	
SMS	-0.02	0.017	380	19.2	4.66	x > 19.54	
# of signals	-0.13	0.26	380	2.9	4.66	x < 3	

represented in Figures 5.6 to 5.9.

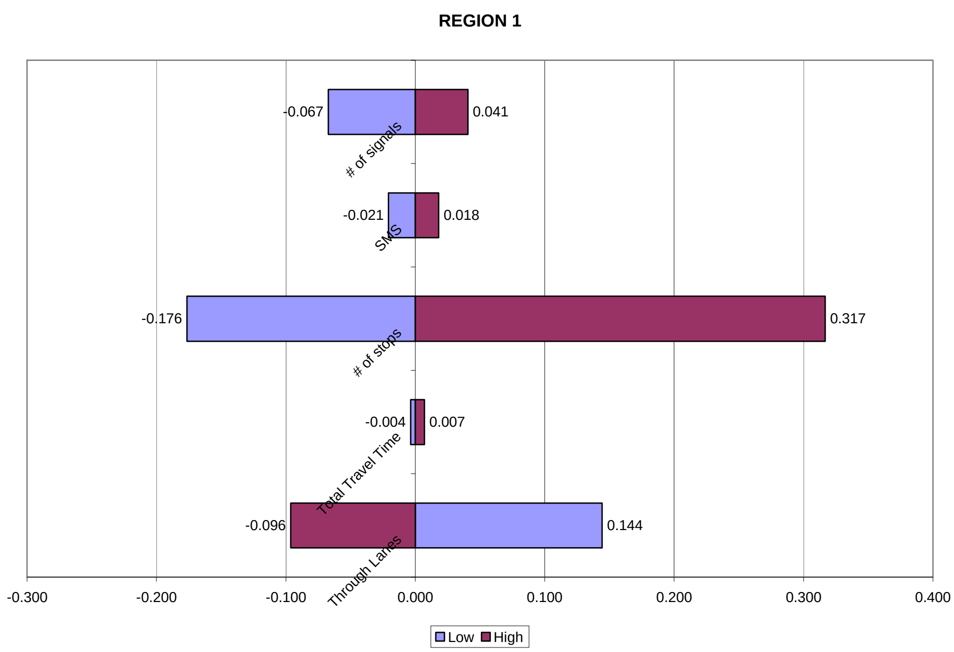

Figure 5.6 Relative Impact Graph for New Haven CT region

Figure 5.6 for the New Haven CT region shows that the largest relative difference was for number of stops attribute where the high performance impact was almost twice the low performance impact. The number of signals attribute has a slightly greater low performance impact than high performance. Total travel time and space mean speed attribute had almost equal impacts in low and high performance. The one unique finding was the inverse impact of number of through lanes where high performance had a negative impact on satisfaction.

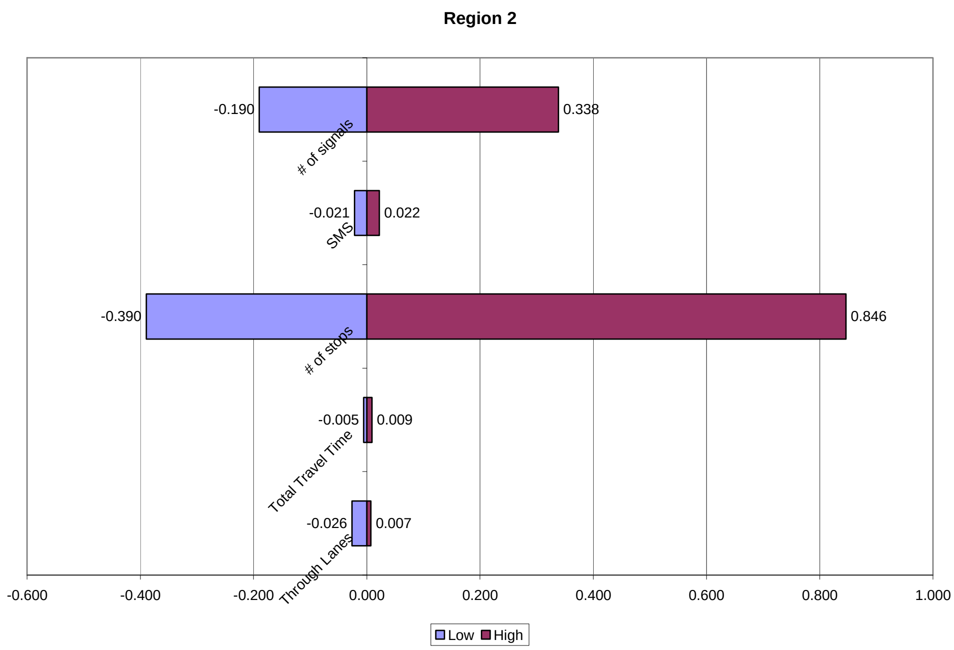

Figure 5.7 Relative Impact Graph for Chicago, IL region

The Chicago IL, region shown in Figure 5.7 has a very strong impact on satisfaction for high performance in number of stops and number of signals attributes. The total travel time and space mean speed attributes have an almost equal impact. And the number of through lanes attribute has a stronger impact for low performance.

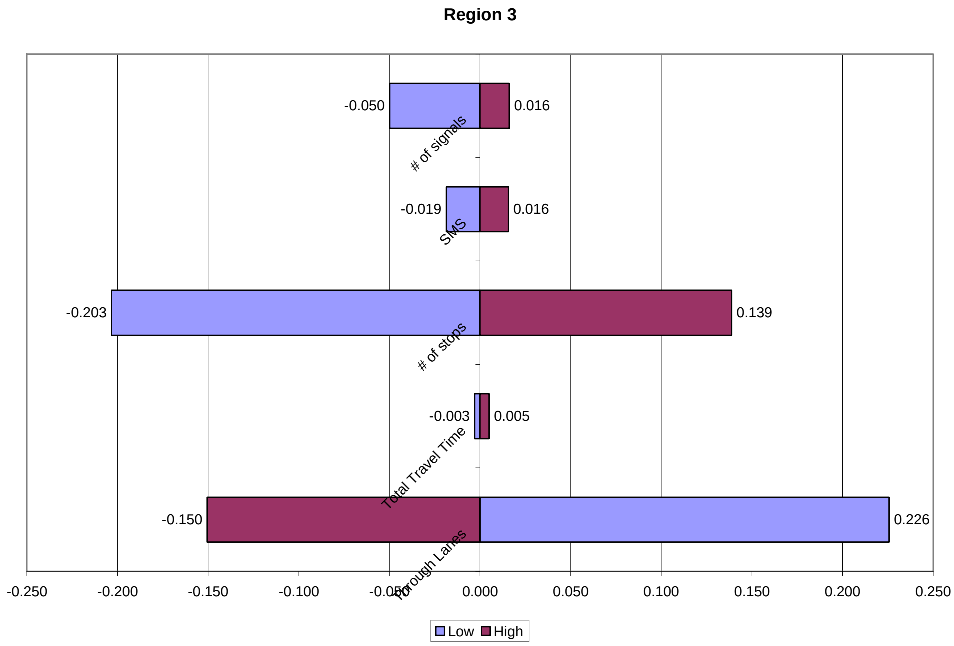

Figure 5.8 Relative Impact Graph San Francisco, CA region

The San Francisco CA region depicted in Figure 5.8 shows an equivalent impact of high and low performance on satisfaction for space mean speed and total travel time attributes. The number of signals and number of stops attributes have a greater impact in low performance; with number of stops have a stronger impact. And lastly, the number of through lanes attribute has an inverse relationship, similar to Region 1.

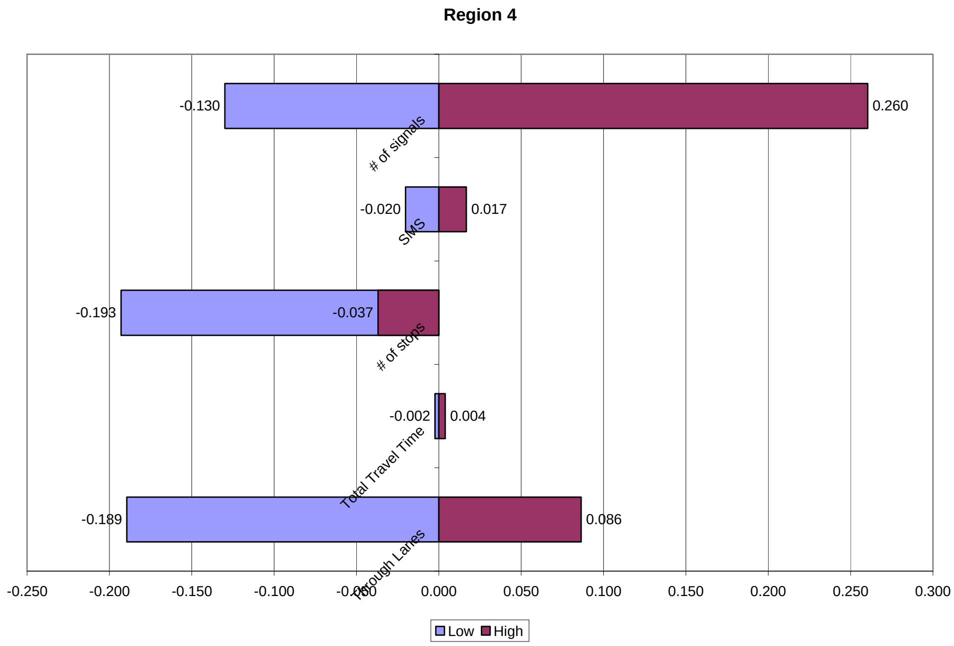

Figure 5.9 Relative Impact Graph College Station, TX region

Figure 5.9 for the College Station, TX region shows that they have the largest relative impact for high performance for the number of signals attribute. Similar to the other regions the space mean speed and total travel time attributes are almost equal. The number of through lanes attribute displays a strong impact for low performance. Lastly, the number of stops attribute has a negative impact on satisfaction whether the performance is high or low.

When comparing the aggregate and disaggregate relative impact graphs a different picture emerges. The relationship of attributes is not always consistent when separated by region. For example, in region 2 (Chicago, IL) and region 4 (College Station, TX) the number of through lanes attribute is a SM attribute, meaning fewer through lanes has a greater impact on satisfaction. While, region 1 (New Haven, CT) and region 3 (San Francisco, CA) the same attribute has an inverse relationship to satisfaction, meaning more lanes creates less satisfaction. Each region's results differ from the overall results which suggest that the satisfaction performance relationship must be considered at least at the regional level. Since attitudes and expectations vary over regions an aggregate approach may lose some valuable information necessary for decision making.

This analysis enforces the importance of how the organization of the data impacts the interpretation of results. Table 5.17 lists the differences in attribute determination based upon the organization of data, which is equivalent to the level of analysis.

Table 5.17 Aggregate vs Disaggregate Attribute determination

Attribute	Nature of Attribute				
	Aggregate	Disaggregate			
	All Regions	Region 1 (New Haven, CT)	Region 2 (Chicago, IL)	Region 3 (San Francisco, CA)	Region 4 (College Station, TX)
Number of Signals	SE	SM	SE	SM	SE
Space Mean Speed	PF	PF	PF	PF	PF
Number of Stops	PF	SE	SE	SM	SM (+/-)
Total Travel Time	SE	SE	PF	PF	PF
Number of Through Lanes	SE	SE (inverse)	SM	SE (inverse)	SM

From Table 5.17 only the space mean speed attribute remains consistent across all regions and with aggregate & disaggregate results. These results indicate that speed is a linear symmetric performance attribute. While the determination of other attributes like stops and travel time vary by region.

Three notable exceptions are evident in the results. First, number of through lanes for regions 1 and 3 have an inverse relationship with satisfaction meaning the higher or better the performance the more negatively it impacts satisfaction. This was discussed earlier and may reflect a regional bias toward more travel lanes. Lastly, number of stops in region 4 has a negative impact for high and low performance. This means that customers in this region are not satisfied no matter the performance. It is possible that unknown factors are being reflected in the data, for instance the number of stops attribute is highly related to the number of signals attribute.

5.4.3.7 Tests of model significance

To verify that the findings from these analyses are statistically significant and not a result of sampling error, a test of significance of model coefficients is conducted. The model results for each of the regions is a subset or (nested version) of the model for all regions together. Therefore using the F test of significance of the sum of squared error (SSE) where H_0 = no difference in coefficients. The results are listed in Tables 5.18 and 5.19.

Table 5.18 Significance of nested models (for low performance tests)

Lows						
Attribute	SSE (p)	MSE (p)	Region 1 SSE (n)	Region 2 SSE (n)	Region 3 SSE (n)	Region 4 SSE (n)
Through Lanes	2077.3	1.497	459.13	555.28	459.86	522.17
F-Stat			-360.31	-338.90	-360.15	-346.28
Total Travel Time	1919.5	1.383	435.00	455.66	447.02	517.95
F-Stat			-357.80	-352.82	-354.90	-337.80
# of Signals	1937	1.396	454.20	423.74	466.26	504.93
F-Stat			-354.06	-361.33	-351.18	-341.95
# of Stops	1896.7	1.366	446.81	425.38	444.65	512.83
F-Stat			-353.80	-359.03	-354.33	-337.69
SMS	2041.7	1.471	454.61	549.12	466.02	528.56
F-Stat			-359.64	-338.22	-357.05	-342.88

Table 5.19 Significance of nested models (for high performance tests)

Highs						
Attribute	SSE (p)	MSE (p)	Region 1 SSE (n)	Region 2 SSE (n)	Region 3 SSE (n)	Region 4 SSE (n)
Through Lanes	2079.9	1.499	459.13	555.44	459.86	527.84
F-Stat			-360.41	-338.99	-360.25	-345.13
Total Travel Time	1984.4	1.43	438.46	511.27	459.95	523.96
F-Stat			-360.36	-343.39	-355.35	-340.43
# of Signals	2020.1	1.455	460.71	503.76	471.48	503.31
F-Stat			-357.25	-347.39	-354.78	-347.49
# of Stops	2058.7	1.483	454.17	515.35	470.14	533.08
F-Stat			-360.65	-346.90	-357.06	-342.91
SMS	1959.7	1.412	444.79	504.25	452.25	515.57
F-Stat			-357.63	-343.59	-355.87	-340.92

Using the F-Test table with 3, and over 120 degrees of freedom the F- statistic at 95% confidence level is determined to be 3.0, not rejecting the null hypothesis results in an interpretation that the model results are not significantly different.

5.4.4 Summary of asymmetrical nonlinear concept test

This case-study used data collected in the NCHRP 3-70 report to test the asymmetrical nonlinear relationship of customer satisfaction to performance hypothesis. The findings support the hypothesis that the impact of positive performance differs from the impact of negative performance. The case-study also identifies that these relationships can vary in different regions and that results are not generalizable across regions. Although the source data can portray the relationship of customer satisfaction to performance, specialized experimental design to account for missing data and representative sample is necessary to provide deterministic results.

CHAPTER 6

DISCUSSION

6.1 Introduction

This chapter details the tasks and findings from the previous chapters and discusses their relevance to the customer satisfaction literature, each of the research task results and the feasibility of the framework. This chapter also lists potential applications of the proposed framework and some lessons learned through this research effort.

6.2 Discussion of Literature

The literature merged three broad bodies of knowledge (customer satisfaction in transportation, customer satisfaction in planning and customer satisfaction in non-transportation literature) to develop an understanding and basis for research of customer satisfaction in transportation decision making research. The literature review identified six questions (Chapter 2, Table 2.1) posited at the onset of the literature review. This section will discuss the answers to those questions and how it helped determine the direction of research.

1 *Can Customer Satisfaction be used in empirical analysis?*

   The literature demonstrated (Anderson 2000; Matzler 2004) and the asymmetrical nonlinear concept test (Chapter 5) confirm that there is a methodology to empirically assess customer satisfaction with respect to attribute performance.

2 *What research has been done in Customer Satisfaction?*

There has been extensive research in customer satisfaction three of the major findings include:

a. Relationship between customer satisfaction and attribute performance is not always linear. (Anderson 2000; Matzler 2004; Kondo 2001; Pollack 2008)
b. Customer satisfaction is developed by both objective and subjective elements (Halstead 1996; Kondo 2001; Van Ryzin 2004); it is experiential in nature and cognitive in form. (Oliver 1980; Cantalupo 2002; LaTour 1979)
c. Customer surveys have been conducted by transportation agencies for years but their usage in decision making has been ad hoc and anecdotal. (Handy 2008; Kelly 2005)

3 *How is Customer Satisfaction currently used in transportation context?*

The literature (Stein 2003; DOT State Measures, 2010) and results of the targeted practitioner document review (Chapter 5) identify that customer satisfaction is primarily used as a goal in or as a dashboard type measure in current transportation contexts.

4 *How can Customer Satisfaction be used in transportation context?*

The results of targeted practitioner survey, the document review and results of the asymmetrical nonlinear concept test (Chapter 5) suggest that customer satisfaction can be used as a tool to address customers need for transparency, and as a data measure in empirical models to predict policy impacts (see framework Chapter 3).

5 *What is Customer Satisfaction?*

Customer satisfaction as this research defines it is a cognitive process that balances expectations and perceived performance of both subjective and objective elements of their experience. This is quite like the transportation planning process in that some elements are technical (objective) while others are political (subjective) but they work in concert to promote the best decision making.

6 *What is the best way to measure Customer Satisfaction?*

From the literature (Oliver 1980; Spreng 1996; Pollack 2008) the best way to measure customer satisfaction is to collect expectation data directly, not subtractive; use both objective and subjective quality of service attributes; then use disaggregate approach toward customer segmentation to address behavioral intentions (Chapter 5).

These questions provided a roadmap of how to conduct the research. Questions 1, 4 and 6 were not answerable prior to the research activities, however questions 2, 3, and 5 lead to the hypothesis identification (question 2), setting the context for research application (question 3) and what type of data to use (question 5). Questions 1, and 6 are the proof of concept and the answers were derived not only from the literature but primarily from the asymmetric nonlinear concept test. Proving the methodology then allowed Question 4 to be answered by the proposed framework.

6.3 Discussion of Results

6.3.1 Planning Process Review

This task was intended to identify additional customer satisfaction analysis points within the existing planning framework. Three stages of the existing planning process were identified as opportunities for customer satisfaction applications, both qualitative and quantitative inputs. This result was different from the initial expectation, adding the data stage to the framework.

This task was fundamental in the development of the framework because it identified where the additional knowledge would and could be used. It was always an objective of this research to provide a seamless integration. By using the existing planning process as a basis for the framework development assures less turbulence for implementers. Since the nature of the stage is familiar only additional data, analysis and formatting methods are required.

Policy implications of this task are clearly identified modifications to the process, identifying integration locations for customer satisfaction applications.

6.3.2 Practitioner Review

This task included a survey of targeted practitioners and a review of their planning products, specifically the long-range transportation plan (LRP), and if available their performance/ monitoring plan. The intention of this task was two-fold 1) to identify how innovators in customer satisfaction were collecting and using their data and 2) to determine the organizational, institutional and political opportunities and challenges to integrating the proposed framework.

This task used a targeted approach rather than a global one, because customer satisfaction usage is still novel in transportation contexts. It was assumed the vast majority of agencies in a global review would not have applicable responses. The survey response rates was 100% (8/8) for both MPO and DOT response. The second iteration survey was designed to increase response rates and reduce the time requirement to complete. However, the second iteration targeted predominately MPO practitioners and their response rate was lower. The target itself of eight (8) agencies is not a statistically significant sample to generalize their responses. However, the eight targeted agencies represent varying populations, geographical regions and most importantly usage of customer satisfaction.

The survey and review were intended to give a sense of the variation among these innovators of customer satisfaction. This was a key finding of the review that there is no standard approach to using and collecting customer satisfaction data. This variation is both a limitation and a benefit to the applications of customer satisfaction. It is a benefit for each agency, and any agency, which aspires to use customer satisfaction in a more explicit manner, has the flexibility to design a program that works and is customized to the agency needs. This is also the limitation that each agency has to 'reinvent the wheel'. As more agencies elevate customer satisfaction usage these pioneering efforts may be reproduced or used as a basis for the refinement and customization of future efforts.

Another key finding is the use of terms like 'Quality of Life'. Practically all of the targeted practitioners included a quality of life statement in the LRP. However the implicit definition varied tremendously. For example, Delaware DOT has measures for their quality of life goal like "enhance security and safety for all DelDOT services and facilities" and "Continue implementing context sensitive design programs" (DelDOT, 2002), among others, while Florida DOT has measures like "Preserve natural environment" and "Use effective public involvement" (FDOT Planning Homepage, 2009). All of these measures are arguably components of Quality of Life however their scope and meaning is so diverse from one another even though their LRPs report the same goal of Quality of Life. It seems that customer satisfaction would be a quality of life element however that determination is agency dependant.

Minnesota DOT and CMAP, Chicago region MPO, have explicit customer satisfaction performance measures listed in their performance and monitoring reports. However the scope of the measure is very different. Minnesota's metric measures the reliability of communication while CMAP's metric measures the improvement on customer surveys. Both agencies use customer surveys to measure their metric but the metric itself measures very different things. Both are valuable elements of customer satisfaction and showcase an approach toward customer-focused service.

The results of this task also influenced the choice of feasibility attributes for the proposed framework. The institutional and standardization attributes are directly pulled from the survey responses that the process is not formalized, and that what type of data is collected and how attributes are determined is highly variable. Another interesting finding from the survey was that some agencies consider customer satisfaction as the overall measure of performance while other agencies identified it as a key measure but not overarching.

There was a disconnect between the survey responses and the documents these agencies published. The documents reviewed may be divergent from survey results because of the timeframe of the LRP. Several of the agency documents did not mention the innovative customer satisfaction work being conducted in the region. For example, Maryland SHA had a robust and sophisticated Customer Satisfaction Index (CSI) that they use to monitor their performance, but this was not listed as a measure in their document (Maryland survey response). Also, Delaware DOT uses an IPA matrix (Cantalupo, 2002), which has its faults but is far more advanced than a trend analysis which was reported in the survey response. As part of the literature review scholarly publications and reports for the targeted practitioners were reviewed this is in part why they were selected for participation in this task. This task highlighted some of the discrepancies between the survey responses, the planning documents and the published customer satisfaction literature.

6.3.3 Asymmetrical Nonlinear Concept Test

This task had two major outcomes 1) the development of a customer satisfaction methodology and 2) the identification of a new transportation tool, the relative impact graph. This concept test measured the hypothesis that the impact of negative performance is different than the impact of positive performance on the satisfaction of customers.

The most significant result from this task was that there is evidence to support the hypothesis. However the experimental design of the source data must be modified to prove the hypothesis. Expressly, attribute performance was measured objectively for the source data but to prove the hypothesis should be rated by respondents based upon their expectation of performance. This modification does not affect the methodology used but fundamentally changes the interpretation ability of the results. Specifically, the mean value of performance should be determined by the respondents. This mean value is used to separate high performance from low performance, if using objective measurement like in this research, the result is less meaningful. This is because the model of customer satisfaction includes perceived performance. An objective measure does not meet this criterion. The lack of a subjective performance rating also limits the ability of this research to relate objective to subjective elements of the satisfaction relationship. However using these data, which is by far the most comprehensive customer perception data available to date; there is still evidence of a difference between high performance and low performance on customer satisfaction.

The asymmetrical nonlinear concept test provided intriguing results. First the ratings for each clip encompassed the entire range of responses. That means that for each clip at least one respondent gave it a rating from best to worst. This is an intriguing finding because it was assumed from the onset that respondents would rate each clip similarly. If using the mean of these rating or the mode this is true but there were outliers for each clip. It was not anticipated that outliers would in fact be the norm. What this means for customer satisfaction is that the perception of performance is highly variable among respondents. This is a significant finding not because it is unexpected but because it is captured empirically. Having tools to prove this concept allows new tools to be developed that can address it in other aspects of transportation design, maintenance and operations.

Five attributes were used for the analysis; these attributes met the three criteria of being observable, tangible and actionable. However, the overlap and interdependence of the attributes may have skewed the results. For example, the number of stops will be influenced by the number of signals. It is possible that signals were green for the entire time of the clip but the presence of the signal indicated a higher probability of higher number of stops. The modified experimental design will have to address the correlation issues of the attributes, because it also impacts the linear regression assumption of independent variables.

The relative impact graph is a useful tool and unusual in transportation contexts. However, it graphically represents the impacts of high and low performance on customer satisfaction relative to zero. The procedures to develop this graphic are not difficult or complex. The graphic itself however, is unique in the type and quantity of information it can provide.

Another key finding from the concept test was the difference in relationship determination at the aggregate and disaggregate level of analysis. The interpretation of the attribute impacts on satisfaction is significantly different at different levels of analysis. For example, the number of stops attribute at the aggregate level is different from each of the regional determinations (see Table 5.17, reproduced here as Table 6.1).

Table 6.1 Aggregate vs. Disaggregate Attribute Determination

Attribute	Nature of Attribute				
	Aggregate	Disaggregate			
	All Regions	Region 1 (New Haven, CT)	Region 2 (Chicago, IL)	Region 3 (San Francisco, CA)	Region 4 (College Station, TX)
Number of Signals	SE	SM	SE	SM	SE
Space Mean Speed	PF	PF	PF	PF	PF
Number of Stops	PF	SE	SE	SM	SM (+/-)
Total Travel Time	SE	SE	PF	PF	PF
Number of Through Lanes	SE	SE (inverse)	SM	SE (inverse)	SM

The variation at these levels of analysis also validates the assumption of regionally based perspectives and provides empirical support. For example (from Table 6.1), the number of through lanes attribute was found to be Satisfaction Enhancing (SE) having a greater impact in negative performance ranges for New Haven and San

Francisco respondents. This finding can be interpreted to mean customers in these regions prefer, or are more satisfied, with fewer lanes. This finding is only relative to the regions where data was collected, however this methodology can be used to determine satisfaction preferences and is generalizable. The common interpretation of customer desire would contradict this finding, typically the more through lanes the less congestion and the greater satisfaction. This is a generalization more through lanes does not always equate to less congestion however in engineering operations it is often considered an option to address congestion issues. This finding of an inverse relationship (SE) for this attribute in the subject regions exposes a regional preference which can influence decisions regarding lane adding projects.

The determination of an attribute's relationship to customer satisfaction is a valuable resource justification tool. If decision makers know their regional preferences than they have more information in the evaluation of projects, programs and policies that can lead to improved customer satisfaction. This tool has the potential to determine performance thresholds for attributes lessening the possibility of diminishing returns. For example, in New Haven decision makers may determine that having four through lanes is not cost effective given their residents prefer fewer through lanes. This type of analysis has not been validated by the data but the potential for it is promising. There would need to be extensive additional research on a regional basis to ascertain the optimal performance threshold for individual attributes. And those thresholds would require observation over time. It is likely that the relationship determination may change over a period of time. For example, the residents of New Haven currently prefer fewer lanes but it is possible that 10 years from now those preferences will change. This does not negate the value of the effort to determine the performance threshold only that careful and consistent evaluation is necessary to provide the most benefit.

The implications of this methodology and tools are far reaching and could change the way decisions are made. Having an empirically based customer preference defined for a specific region can provide the justification needed for resource allocation.

6.3.4 Key Findings

This section reiterates and lists the findings discussed in prior sections. These findings are from the practitioner review and asymmetrical nonlinear concept test:

1- No Standard approach to using and collecting customer satisfaction data.

2- Quality of Life term is a buzzword in planning documents however the definition and scope varies significantly.

3- The customer data application, inclusion, and integration process is not formalized

4- Customer satisfaction is characterized differently among agencies, either overall measure of greater importance or as a key measure of equal importance.

5- Cannot reject hypothesis that ‘impact of negative performance is different than impact of positive performance on the satisfaction of customers’ which indicates an asymmetrical nonlinear relationship of attribute performance to customer satisfaction.

6- Empirical evidence of performance perception variability among customers.

7- Relative importance graph is feasible in transportation context

8- The level of analysis (aggregate/national vs disaggregate/regional) results in different determination of attribute performance to customer satisfaction relationship.

9- The methodology is generalizable.

6.4 Discussion of Proposed Framework

6.4.1 Attributes of feasibility

The attributes of a feasible framework initially presented in chapter 3, are revisited to determine if the framework met those criterion. The attributes are not metrics and they can be a little bit or completely true/false however the answer is simply yes, the attribute is present or no, it is not. If the framework does have some aspect of the attribute the answer is affirmative. Perhaps in the future there may be additional attributes and metrics that can provide a better determination of how well the framework can accomplish set goals.

☑ Formal procedure for usage of customer satisfaction data

Yes, the framework provides explicit procedures for collecting, using and interpreting customer satisfaction data, which can be included in an agency's written procedures.

☑ Standardizes data collection

Yes, the framework identifies what specific data is needed to use the analysis methods outlined in the methodology.

☑ Is a systematic analytical model for customer satisfaction in decision making.

Yes, the framework uses the existing transportation planning process as a basis for integrating customer satisfaction elements. It uses an empirical methodology to determine attribute relationships.

☑ Uses existing data as much as possible, leverages existing resources

Yes, most of the data traditionally collected is used by the new framework with the addition of a few new data requirements for use in the analysis methods.

☑ Simple to use and explain, yet appropriately complex to accommodate customer satisfaction elements

Yes, the analysis methods do not use new methodologies just existing ones in new ways to determine the attribute relationship to satisfaction. This relationship is then intuitively represented by customer satisfaction.

☑ Conducts an empirical analysis of customer satisfaction

Yes, the framework uses both existing and new data to conduct the analysis of customer satisfaction.

☑ Fits into current transportation planning framework

Yes, the transportation planning process is the basis for the proposed framework. It follows the same steps and process with additional data, analysis methods and evaluation techniques.

☑ Uses both qualitative and quantitative data

Yes, the customer ratings are qualitative measures that are transformed into quantitative metrics for analysis using relative impact graphs.

☑ Address both technical and political aspects of planning process

Yes, the framework includes element of technical analysis and political evaluation in its structure.

☑ Flexible to accommodate customization and adaptation

Yes, the framework is proscriptive not prescriptive, meaning it does not limit the data analysis or evaluation tools but provides a standard level of consideration and dialogue to determine if customer satisfaction is being integrated in the decision making process.

The proposed customer satisfaction framework is theoretically feasible but many of the technical aspects are to be determined through future research. However the structure is relevant and an asset to integrating customer satisfaction in transportation decision making. The proposed framework can be used to assess the customer satisfaction practices of an agency.

6.4.2 Customer Satisfaction as Decision Making Tool

This section discusses how well customer satisfaction as a tool meets the goals outlined in the introduction of: providing better resource allocation justification, transparency in decision making, setting realistic performance goals and the ability to address expanding planning goals.

Resource allocation justification

The justification of project selection and resource allocation is traditionally accomplished by performing a Cost-Benefit Analysis (CBA) in the evaluation phase of the planning process. The customer satisfaction tool can provide greater insight to regional preferences, as mentioned in the discussion of the concept test. If customers/residents of a region have strong preferences for certain attribute performance levels it can give decision makers more evidence to base their selections and an analytic approach to justify them.

Transparency in decision making

Transparency, defined here as when choices are justified and traceable through a logical, cost-effective and public-focused process, no black-boxes. Even the best ideas are subject to evaluation. Therefore having a better, more effective and transparent process to compare and evaluate alternatives is valuable. Customer satisfaction is an intuitive metric, like cost, that most understand implicitly. Education of decision makers is a huge task, explaining the engineering outcomes, challenges and tradeoffs as well as the impacts of each choice, and it has to be done perpetually because decision makers change every election season. Assuming a rational actor model of decision making, political figures would have to be engineers and spend even more time weighing options. An intuitive metric like customer satisfaction can relieve some of the education requirements of not only decision makers but the public as well. This time savings is also a value to the process because it is common language for all stakeholders. The common language of customer satisfaction allows decision makers to explain their choices and how those choices were made which is the goal of a transparent process.

Setting realistic performance goals

Performance measurement is relatively new but exceptionally vast body most public agencies have some type of performance measures. Performance measures can be different from various perspectives (internal agency, customer, politico, and media) and the important measures differ depending on which perspective is taken. Customer satisfaction is a cross-perspective measure. Additionally, the methodology used in the concept test can be furthered to determine thresholds of performance that maximize customer satisfaction. This potential is invaluable; the current thinking is more is better. However from the concept test it was illustrated that is not always the case. Take the New Haven and San Francisco example of preference for fewer lanes. The common thinking that more through lanes is improving performance, would lead to less satisfaction in those regions. Using customer satisfaction as tool can highlight these incorrect assumptions.

Addressing expanding planning goals

It is obvious that transportation planning has grown well beyond the boundaries of asphalt and concrete. Quality of life was the common goal in the practitioner document review. There is still a great deal of effort in the transition of the planning process but customer satisfaction as a tool can help address the broader issues transportation planning is dealing with. Case in point social equity issues, traditional approaches would measure the amount of access or services provided to varying social groups. However it is possible that the amount does not tell the entire story. If for instance a low income area has an equal amount of access to transit that does not mean they have an equal amount of satisfaction with transit, or that the equal amount servers their needs. Service equality is not service equity (Kelly 2004). The implications of this tool in addressing social equity is huge, it provides another comparison point for public agencies to assess their services and their accommodation of the varying needs of their customers.

6.5 Recommendations and Lessons Learned

This section lists recommendations and lessons learned through out the research effort.

- Modify concept test experimental design
    - Collect expectation of performance ratings from respondents
    - Collect attribute performance ratings from respondents in addition to measured performance
    - Address the multicollinearity issues among independent variables
    - Collect customer satisfaction rating directly not proxy of level of service

    - Use a representative sample

- Social equity applications of customer satisfaction tool can be more significant than resource allocation applications.
- A broader practitioner survey should be taken to determine penetration of customer satisfaction practices, which can lead to more support amongst agencies working this issue.
- Aggregating individual attribute relationships to satisfaction for project level is difficult, even more difficult if aggregating to a regional level. This will be a considerable undertaking to develop however there are various multi attribute utility techniques that may be able to address aggregation on a smaller scale.

6.6 Summary

This chapter appraised the questions posed at the beginning of the literature, the results of each of the research tasks, and the feasibility attributes of the proposed customer satisfaction framework. Connections were drawn between the various research tasks and the literature which led to a listing of key findings and lessons learned from the research as well as recommendations for future research. The outcome of the discussion is that the asymmetrical nonlinear concept test and the proposed customer satisfaction framework are valid for improving customer satisfaction in transportation decision making.

CHAPTER 7

CONCLUSION

7.1 Introduction

Decision making in transportation balances system needs with customer desires in a financially-constrained environment. This research has developed a new tool for decision making that is based upon the accurate relationship of customer satisfaction and attribute performance. This tool can potentially minimize wasted resources through diminishing returns of performance improvement for asymmetrical nonlinear attributes.

Maintaining high quality services and satisfying the customers are the objectives of resource decision making in the planning process. The process incorporates a variety of perspectives (technical, public and political) the customer satisfaction tool developed in this dissertation can provide a common language for these disparate perspectives. It also addresses the broader social goals of transportation plans that traditional analysis tools can not accommodate.

Leveraging research from product-based industries and public administration this dissertation transforms a theoretical concept into an applicable tool for use in transportation contexts. This tool makes use of the data commonly collected by transportation agencies, simple mathematical processes and the existing planning framework to improve customer satisfaction in decision making.

7.2 Summary

This research investigated several bodies of literature to find applicable non transportation methods and models of customer satisfaction. The expectancy disconfirmation model found in product-based literature serves as the structure for an empirical methodology in the transportation context. Utilizing existing resources, the vast customer surveys already conducted by transportation agencies, was a selection factor for potential models.

The proposed customer satisfaction framework identified three opportunities to incorporate customer satisfaction into the transportation planning framework. Customer satisfaction application in the data, analysis methods and evaluation stages improve the existing transportation planning process's ability to integrate customer satisfaction throughout the process. This framework provides a transparent process that can be used in resource justification and social equity determination giving decision makers the tools necessary to address broader goals of transportation agencies.

This framework was developed based on the responses of targeted customer satisfaction practitioners regarding their practices in collection and analysis of customer data. It was also developed based on the review of practitioner's planning documents that frame the vision, goals and performance measures in use. And most importantly, the framework depends upon the methodology created to determine the nature of an attribute. This methodology provides understanding of the satisfaction-performance relationship that may impact resource allocation. The methodology is an empirical process that transforms qualitative customer satisfaction data into a decision tool. Utilizing the relative impact graph the impact of attribute performance on satisfaction can be determined.

Traditional transportation decision tools implicitly assumed a direct linear relationship of attribute performance to customer satisfaction, i.e. more/better performance equals more satisfaction. The tool developed here to determine the true relationship of performance-satisfaction is based upon product-based industry research findings. Using this tool in a transportation context requires specific alterations to the methodology. This research used transportation data to test the hypothesis that the impact of high performance differs from the impact of low performance on customer satisfaction. The results support the hypothesis but the experimental design of the data used precludes confirmation of the hypothesis. However, the methodology and tools are confirmed as relevant in the transportation context and support the feasibility of the proposed customer satisfaction framework.

The research conducted is exploratory which means the outcome and contribution are more perspective based. Although a valuable methodology is developed the true impact is the shift from customer satisfaction as a goal to customer satisfaction as a tool to transparency in decision making. The research question 'Is there an empirical customer satisfaction analysis?' is confirmed. The hypothesis of a different impact of positive performance and negative performance on customer satisfaction is also supported but requires a modified experimental design to confirm. The proposed customer satisfaction framework meets the criteria for feasibility and can seamlessly integrate within the existing transportation planning process.

7.3 Research Contributions

The contributions of this research are: 1) empirical evidence of the nonlinear asymmetrical concept of customer satisfaction and attribute performance relationship. 2) a perspective shift from customer satisfaction as a goal to customer satisfaction as a decision making tool.

The first contribution, empirical analysis of customer satisfaction, was determined by developing a methodology from product-based literature for application in a transportation context. This methodology was used to test the assumption of linear satisfaction-performance relationships implicit in many transportation decision tools like the importance-performance analysis (IPA) matrix (Stradling, 2007; Cantalupo, 2002).

The other contribution of this research is a perspective shift. This research explored the perspectives of customer satisfaction in transportation contexts conducting surveys, reviewing planning documents and reviewing varied bodies of literature. This transportation perspective was primarily of customer satisfaction as a goal, something separate and outside the decision making system. However, the contribution of this research is a shift of customer satisfaction as only a goal to customer satisfaction as a tool to attain broader transportation planning goals, specifically social equity goals.

7.4 Significance

The significance of the empirical analysis of customer satisfaction contribution is that transportation agencies can use this tool to determine if more/better performance is warranted with respect to customer satisfaction. For example, an agency may want to build more through lanes to reduce congestion knowing that their customers have an inverse satisfaction relationship to number of through lanes - as was found in New Haven, CT and San Francisco, CA (section 5.4.3.6) the allocation of resources to this task in not justified. It is likely that decision makers in this region anecdotally, know this is true of their constituents but the significance of this tool is they have a tool to systematically and objectively confirm it.

The significance of the second contribution, perspective shift, is that it provides a tool for previously unmeasured goals. The impact of this contribution is much broader. This tool can be used outside of transportation contexts to determine social equity by means of customer satisfaction. The public administration policy industries conduct research in this area. This is a contribution in all of these contexts.

7.5 Impact

The empirical customer satisfaction analysis contribution is contrary to conventional thinking and practice in transportation contexts. The asymmetrical nonlinear concept is new to transportation. Current tools assume a linear relationship between customer satisfaction and attribute performance and potentially diminish the return of their resource investments. This contribution will impact the tools in practice and the development of new tools. The impact of this contribution is expansive; any region can use the methodology to determine their customer satisfaction-attribute performance relationships.

The second contribution is a new concept in transportation contexts, the use of customer satisfaction as a tool to address broader planning goals. This contribution can impact the way decisions are made by including accurate relationships of performance and satisfaction also being able to trace decisions back to the public (customer) input. It may also impact the way customer satisfaction is perceived in transportation contexts as more than a marketing and public relations effort by linking it to decision making.

7.6 Limitations

The limitations of these contributions are the experimental design modifications required to confirm the hypothesis of asymmetrical nonlinear relationships, the undeveloped aggregation strategy of the relationship determination at a regional level, the necessary ongoing research to develop performance thresholds for attributes, and developing a management approach for presumed temporal shifts of customer satisfaction.

Most of these limitations can be addressed by additional research. The refinement of research needs to make customer satisfaction an applicable tool in transportation decision making is an additional contribution of this research.

7.7 Future Research

This research area is prime for further investigations. Below several direct offshoots of this research are listed with many indirect research branches as yet to be determined.

The five research topics are:

1) Conduct asymmetrical nonlinear concept test with modified experimental design.

2) Track temporal aspect of customer satisfaction-attribute performance relationship.

    How often or for how long is the relationship one “type”

    What causes the shift? Exposure, experience, demographic changes etc.

3) Determine aggregation tool to ‘roll-up’ attribute relationships.

4) Test customer satisfaction tool for social equity determinations.

5) Threshold of performance

Customer satisfaction as a decision making tool has many potential applications and research needs. This dissertation refined some of the questions to be investigated by exploring the broad customer satisfaction literature and applications of transportation practitioners however the future of this topic can go forward in many fields and many directions.

7.8 Final Thoughts/ Closure

In closing, this dissertation explored the customer satisfaction theories and applications in various fields to determine its value in transportation contexts. The evidence of an asymmetrical nonlinear customer satisfaction relationship to attribute performance conflicts with current transportation decision tools and implicit assumptions of analysis tools in practice. The methodology to determine these relationships provides a tool for linking customer satisfaction and decision making. This shift in perspective of customer satisfaction as a tool for decision making in transportation contexts can have broad impacts.

APPENDIX A

Table A.1 Sample Data Findings

	Kentucky 1997	Florida 2002	Missouri 2003	Louisiana 2004	Kentucky 2004
Rate of response	professional drivers13.64% & elected officials 34.41%	Resident -36% Well elder - 50% Govt.- 46% Visitor-?	67.10%		
Number of respondents	professional drivers 795 & elected officials 223	Resident -1752 Well elder -397 Govt.-476 Visitor-448	4000	1600	936
Sampling procedure	Used CDL list and transportation center list to mail surveys	random digit dialing, mailing lists and targeted visitors	400 per district, ten districts	Random start, interval sample design	List assisted random digit dialing
Survey area/coverage	Statewide	Statewide	Statewide	Statewide	Statewide
Scale	5 point scale (totally dissatisfied- totally satisfied)	4 point scale + No opinion (strongly agree- strongly disagree)	4 point scale (extremely satisfied- extremely dissatisfied)	A-F letter grading, where A-C are grouped as satisfied	5 point scale (extremely satisfied - extremely dissatisfied)
Timeframe (how often)		2 yrs	every 3 yrs		every 2 yrs
Method	frequency distribution	frequency distribution	expectation measure - perceived measure = gap indicator		frequency distribution
Collection	mail surveys	telephone & mail surveys	telephone survey	telephone survey	telephone survey

(Table A.1 Continued)

	Kentucky 1997	Florida 2002	Missouri 2003	Louisiana 2004	Kentucky 2004
Analysis type	none	none	Mean discrepancy analysis using decision matrix	SPSS Statistical software to conduct frequency analysis	none
Number of interest areas	7 major characteristics	each respondent category had distinct instrument with some overlap	34	7 components of Highway system	7 characteristics
Development procedure		focus groups aided in respondent category definition and interest areas per group	contractor, key stakeholder input & built upon previous survey	consultant	built upon previous surveys with add-ins for additional information
Data collection period		varied 7weeks for resident	5 weeks	4 weeks	5 weeks
Goal identified	To Baseline Customer Satisfaction	Part of Sterling criteria, addressed strategic objective 1.1 to Improve External Customer Satisfaction	no	Address strategic plan objective 2.3 Improve DOTD image & credibility by exceeding & responding to customer expectations & attaining 60% Customer Satisfaction level by FY05	Tracking Customer Satisfaction ratings
other	included a feedback option	included a feedback option		included a feedback option	

APPENDIX B

Figure B.1 Survey Instrument (First Iteration)
Questions for Agencies use of Customer Satisfaction Data in Prioritization

1. Do you collect customer survey data in addition to public involvement data for long-range plan?
2. In not, please answer questions with regard to public involvement data.
3. How often do you collect data?
4. What type of data is collected? (choose as many as apply)
    a. Overall satisfaction ratings
    b. Individual attribute satisfaction ratings
    c. Performance ratings
    d. Attribute importance ratings
    e. Attribute satisfaction ratings
5. How do you identify which attributes to collect customer data for?
6. Do you have open feedback questions?
7. What type of analysis is performed on customer data? (frequency analysis, gap analysis, etc)
8. How is the data distributed within the agency?
9. How is the data used?
10. Which department manages this task?
11. Are their formal procedures for the uses of Customer data identified in ques. 9?
12. What weighting is given to Customer satisfaction in ranking projects?
13. Is there a feedback loop to measure if selected priorities met customer data needs?
    a. Would that be valuable? To whom (which department or organization)?
14. Is Customer Satisfaction a Measure of Effectiveness (MOE) for your agency?
    a. If so, how do you measure it?
    b. Track it?
    c. If not, would it be useful?
15. In your professional opinion what is the importance of Customer satisfaction with respect to other transportation network MOEs?
16. Can your data be made available for further research?

Return to:

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Figure B.2 Survey Instrument (Second Iteration)

Customer Data Survey

This survey is intended to gather information about how public agencies collect, distribute and use their customer data. Recent findings show that a more Customer based approach to decision making is a key goal for many transportation agencies. Taking a few moments to answer the following questions will help to canvas the State of the Practice.

1. Does your agency collect any type of customer data? Please explain

2. How often does your agency collect Customer Data?

- Monthly
- Quarterly
- Annually
- Every two years

Other (please specify)

3. Which Department(s) in your agency collects and/or uses this Customer Data? (if separate departments please identify)

4. Does your agency use its Customer Data for any of the following? (check as many as apply)

- Performance Measurement Metrics
- Risk Assessment
- Public Relations/Outreach
- Strategic Planning
- Long-Term Planning

(Figure B.2 Continued)

5. Does your agency have formal (written) procedures for how to collect, distribute and use the Customer Data? Please explain if yes.

- No
- Yes, Please explain

6. Does your agency collect specifically "Customer Satisfaction" Data? (Where Customer Satisfaction Data are user surveys that ask for ratings of satisfaction and/or performance of specific attributes, projects, or programs your agency is responsible for)

- Yes
- No
- Other (please specify)

7. Does your agency collect any of the following ratings in your Customer Satisfaction efforts? (check as many as apply)

- Performance Ratings
- Importance Ratings
- Desired Performance Ratings
- Expected Performance Ratings
- Other (please specify)

8. If further clarification is needed, who at your agency may I contact to follow-up this survey?

APPENDIX C

Figure C.1 Survey Responses (Delaware DOT)

Questions for Agencies use of Customer Satisfaction Data in Prioritization

1. Do you collect customer survey data in addition to public involvement data for long-range plan? Yes
2. In not, please answer questions with regard to public involvement data.
3. How often do you collect data? Annually
4. What type of data is collected? (choose as many as apply)
    a. Overall satisfaction ratings yes
    b. Individual attribute satisfaction ratings yes
    c. Performance ratings yes
    d. Attribute importance ratings yes
    e. Attribute satisfaction ratings yes
5. How do you identify which attributes to collect customer data for? Modeled other surveys in country
6. Do you have open feedback questions? No
7. What type of analysis is performed on customer data? (frequency analysis, gap analysis, etc) trends analysis
8. How is the data distributed within the agency? Website,hardcopies
9. How is the data used? Performance Measures, Long Range Plan
10. Which department manages this task? Planning
11. Are their formal procedures for the uses of Customer data identified in ques. 9?no
12. What weighting is given to Customer satisfaction in ranking projects?none yet
13. Is there a feedback loop to measure if selected priorities met customer data needs? no
    f. Would that be valuable? To whom (which department or organization)?
14. Is Customer Satisfaction a Measure of Effectiveness (MOE) for your agency?
    g. If so, how do you measure it? No
    h. Track it?
    i. If not, would it be useful?
15. In your professional opinion what is the importance of Customer satisfaction with respect to other transportation network MOEs? N/A
16. Can your data be made available for further research? Yes

Figure C.2 Survey Responses (Florida DOT)

Questions for Agencies use of Customer Satisfaction Data in Prioritization

1. Do you collect customer survey data in addition to public involvement data for long-range plan?
   Yes
2. In not, please answer questions with regard to public involvement data.
3. How often do you collect data?
   Every two years
4. What type of data is collected? (choose as many as apply) **- All**
   j. Overall satisfaction ratings
   k. Individual attribute satisfaction ratings
   l. Performance ratings
   m. Attribute importance ratings
   n. Attribute satisfaction ratings
5. How do you identify which attributes to collect customer data for?
   We first conducted a focus group study to identify the attributes. A couple of years ago, we conducted another focus group study to update the attributes.
6. Do you have open feedback questions?
   Yes
7. What type of analysis is performed on customer data? (frequency analysis, gap analysis, etc)
   Frequency analysis, cross tabulation analysis, trend analysis and qualitative analysis of open-ended questions
8. How is the data distributed within the agency?
   - **The Statewide, Central Office and District Customer Survey Champions discuss the results, and statewide and district-specific presentations are prepared and shared among the champions.**
   - **The champions present the results to the respective office or district.**
   - **The Statewide Champion presents the results to the agency Executive Board.**
   - **The results are also shared through emails and posted on the department's website.**
9. How is the data used?
   - **In our meetings, the champions recommend improvement areas and targets for those improvement areas.**
   - **The Statewide Champion proposes those recommendations to the Executive Board.**
   - **The Executive Board, in turn, makes a decision on those recommendations.**
   - **The respective office or district incorporates the respective improvement area(s) in its Tier 3 or Tier 4 plan.**
   - **The offices and districts implement action plans to improve our customers' satisfaction.**

(Figure C.2 Continued)

10. Which department manages this task?
    The Office of Policy Planning Director under the Assistant Secretary of the Intermodal Systems Development

11. Are their formal procedures for the uses of Customer data identified in ques. 9?
    See reply to Ques. 9.
12. What weighting is given to Customer satisfaction in ranking projects?
    See replies to 14 and 15.
13. Is there a feedback loop to measure if selected priorities met customer data needs?
    Yes
    o. Would that be valuable? To whom (which department or organization)?
    See replies to 8 and 9.
14. Is Customer Satisfaction a Measure of Effectiveness (MOE) for your agency?
    Yes
    p. If so, how do you measure it?
       We identify improvement areas and establish statewide targets for those areas.
    q. Track it?
       - **The department has built this measure (External Customer Satisfaction) into our Business Model and updates the measure as needed.**
       - **We conduct the surveys to our external customers every two years.**

    r. If not, would it be useful?
15. In your professional opinion what is the importance of Customer satisfaction with respect to other transportation network MOEs?
    Our customers are the most important to FDOT. They are users of our transportation system. Their feedback on what's important to them, what improvements are needed and how FDOT does its job helps the department readjust our priorities and investments, improve our performance and meet our customer requirements.
16. Can your data be made available for further research?
    Yes.

Figure C.3 Survey Response (Maryland SHA)

Questions for Agencies use of Customer Satisfaction Data in Prioritization

1. **Do you collect customer survey data in addition to public involvement data for long-range plan?** The Maryland State Highway Administration (SHA) uses customer survey data to help develop its four-year business plan and to help identify program/process improvements.
2. **In not, please answer questions with regard to public involvement data.**
3. **How often do you collect data?** The survey is conducted every two years.

What type of data is collected? (choose as many as apply) All of the types of data mentioned below are collected.

  s. **Overall satisfaction ratings**
  t. **Individual attribute satisfaction ratings**
  u. **Performance ratings**
  v. **Attribute importance ratings**
  w. **Attribute satisfaction ratings**

4. **How do you identify which attributes to collect customer data for?** The SHA used customer focus groups to determine what was important to the customer and then developed questions based on the feedback.
5. **Do you have open feedback questions?** Yes.
6. **What type of analysis is performed on customer data? (frequency analysis, gap analysis, etc)** SHA mainly performs frequency and gap analyses. SHA's main customer satisfaction measure is an index that accounts for the importance of an item according to customer rankings and the level of satisfaction. Because we ask about importance and satisfaction on a list of core functions, we are able to analyze the gap between them; so, highly important items with relatively lower scores need more emphasis.

We are also going to be able to develop trends over time about whether the importance of core functions is changing and, obviously, trends about satisfaction. This year, with two years worth of data, we will be able to look at the statistical significance of changes in ratings, if any. Data is summarized by key performance areas (safety, maintenance, mobility, environmental stewardship and customer service).

7. **How is the data distributed within the agency?** The customer survey results report is distributed to SHA's Senior Management Team (made up of SHA's Administrator, three Deputy Administrators, and 26 office Directors), posted on our Intranet so all employees have access to it, and the findings are also discussed at a Senior Management Team meeting. A separate report is also generated for each of SHA's seven engineering districts with results for the counties in their area of responsibility.
8. **How is the data used?** The data is used to help develop objectives and strategies in SHA's four-year Business Plan, to identify strengths and opportunities for improvement during SHA's self-assessment (conducted every three years), and in some cases, the data is used in combination with performance data to allocate resources. The District results are used to help develop district level business plan goals and objectives.

(Figure C.3 Continued)

9. **Which department manages this task?** The Performance Excellence Division which reports directly to the SHA Administrator.
10. **Are their formal procedures for the uses of Customer data identified in ques. 9?** Use of the customer survey results have been incorporated into the criteria for conducting SHA's internal self assessment every three years.

11. **What weighting is given to Customer satisfaction in ranking projects?** SHA interprets customer satisfaction as the opinion of an end user. We use customer satisfaction to gauge the quality of projects and to determine project scope in many ways. However, project selection is based on input of key stakeholders through our annual "Consolidated Transportation Program Tour" where the capital program is discussed with county elected leaders, often in a public forum depending on the county. It is during these meetings that the counties also present in priority order, the projects they would like to see funded by SHA.
12. **Is there a feedback loop to measure if selected priorities met customer data needs?**
    x. **Would that be valuable? To whom (which department or organization)?**

We are not completely clear on what is meant by "customer data needs." However, SHA's customer index includes rating the importance of specific functions and services that we provide; rather than specific projects. Over time, this will provide information about the relative importance of certain functions and relative funding proportions.

13. **Is Customer Satisfaction a Measure of Effectiveness (MOE) for your agency?**
    y. **If so, how do you measure it?**
    z. **Track it?**
    aa. **If not, would it be useful?**

The customer satisfaction index is used in our annual Managing for Results performance report, part of our budget submission to the Maryland legislature. The method of calculation is as follows:

The overall customer satisfaction measure for SHA is based on the SHA Responsibilities/Functions. Since respondents were asked to rate the importance of 22 functions, these importance ratings are used to weight average the actual grades respondents assigned to each function. In this manner, those functions that were most important to respondents had a greater impact on the calculation of satisfaction than those functions that were identified by respondents as being less important. The first step in this process was calculating the factor for each of the SHA functions. The Weighting Factor (WF) was computed by dividing each function's Mean Importance Rating (MIR) by the sum of all 22 MIRs. The Weighting Factors were then utilized to modify the satisfaction ratings given by each respondent for each SHA function.

We also ask a question in our statewide survey about customer satisfaction with the promptness of responding to requests if a customer contacted SHA. This is summarized as a percent for each letter grade A/B/C/D/F and as an index based on these percentages.

(Figure C.3 Continued)

14. **In your professional opinion what is the importance of Customer satisfaction with respect to other transportation network MOEs?** Customer satisfaction is one important measure of effectiveness. Other important MOEs would include human resources, safety, and budget. The level of importance would vary depending on what the specific measure is related to.
15. **Can your data be made available for further research?** SHA's customer satisfaction data is available upon request depending on the intended purpose.

Figure C.4 Survey Response (Atlanta MPO)

Questions for Agencies use of Customer Satisfaction Data in Prioritization

1. Do you collect customer survey data in addition to public involvement data for long-range plan? Yes, we collect customer satisfaction information from our planning partners about once a year to see if we are meeting their expectations. We also engage in small group discussions with our board and committee members on the same thing. In addition we also poll and survey the general public regarding their views on issues, concepts and projects.
2. In not, please answer questions with regard to public involvement data.
3. How often do you collect data? For customer satisfaction – once a year; for public involvement, once to twice a year for a scientific poll. For online surveys, we usually have a survey going most months out of a year.
4. What type of data is collected? (choose as many as apply)
    - bb. Overall satisfaction ratings yes
    - cc. Individual attribute satisfaction ratings yes for individual work program items not individual staffers
    - dd. Performance ratings yes
    - ee. Attribute importance ratings yes
    - ff. Attribute satisfaction ratings yes
5. How do you identify which attributes to collect customer data for? Valuable, reliable, satisfactory, user friendly and all the shades thereof
6. Do you have open feedback questions? yes
7. What type of analysis is performed on customer data? (frequency analysis, gap analysis, etc) straightforward answers into a report
8. How is the data distributed within the agency? Within division
9. How is the data used? To evaluate how division works with partners
10. Which department manages this task? Comp planning/transportation planning division
11. Are their formal procedures for the uses of Customer data identified in ques. 9? no
12. What weighting is given to Customer satisfaction in ranking projects? no
13. Is there a feedback loop to measure if selected priorities met customer data needs?
    - gg. Would that be valuable? To whom (which department or organization)? no
14. Is Customer Satisfaction a Measure of Effectiveness (MOE) for your agency? I don't know as an agency, we do it as a division. This is very informal.
    - hh. If so, how do you measure it?
    - ii. Track it?
    - jj. If not, would it be useful?
15. In your professional opinion what is the importance of Customer satisfaction with respect to other transportation network MOEs? I'm not sure what you are asking. Other planning partner networks MOEs ?? If this is it, I don't know of MOEs of other agencies.
16. Can your data be made available for further research? Sure

Figure C.5 Survey Response (Minnesota DOT)

Response Type: Normal Response	**Collector:** Customer Data Survey (Web Link)
Custom Value: *empty*	**IP Address:** 156.98.4.11
Response Started: Wednesday, October 28, 2009 9:27:38 AM	**Response Modified:** Wednesday, October 28, 2009 9:44:25 AM

1. Does your agency collect any type of customer data ? Please explain

Mn/DOT has used market research methods for many years. Through the market research process, data is used to create useful information to guide decisions. Data is collected through such methods as telephone surveys, internet surveys, mail surveys and focus groups. In fact, customer satisfaction information is at the core of our overall priorities and is used to develop performance measures for priorities such as pavement conditions, interregional-corridor mobility, and snow and ice removal.

2. How often does your agency collect Customer Data?

Mn/DOT conducts several longitudinal market research surveys as well as one-time market research efforts. For example, Mn/DOT's participation in an annual omnibus survey is a reliable method for tracking public opinion over time and has been in use almost every year since 1987. Questions are on transportation related topics ranging from maintenance services to safety; and from satisfaction to reliability. It is administered to 800 Minnesota households annually. An example of a one-time study is the Speed Enforcement Perception Study conducted in 2005. The intent of the study was to gauge driver reaction before and after an increase in speed limits on some roads and a subsequent increase in enforcement of those new limits.

3. Which Department(s) in your agency collects and/or uses this Customer Data? (if separate departments please identify)

Data is collected by a marketing research section housed within the Office of Policy Analysis, Research and Innovation. All divisions (there are six) utilize customer data in some fashion.

4. Does your agency use its Customer Data for any of the following? (check as many as apply)

Performance Measurement Metrics

Public Relations/Outreach

Strategic Planning

Long-Term Planning

5. Does your agency have formal (written) procedures for how to collect, distribute and use the Customer Data? Please explain if yes.

No

6. Does your agency collect specifically "Customer Satisfaction" Data? (Where Customer Satisfaction Data are user surveys that ask for ratings of satisfaction and/or performance of specific attributes, projects, or programs your agency is responsible for)

Yes

7. Does your agency collect any of the following ratings in your Customer Satisfaction efforts? (check as many as apply)

Importance Ratings

Performance Ratings

8. If further clarification is needed, who at your agency may I contact to follow-up this survey?

Ryan Gaug ryan.gaug@state.mn.us 651-366-3793 651-366-3793

Figure C.6 Survey Response (Puget Sound MPO)

Response Type: Normal Response	**Collector:** Customer Data Survey (Web Link)
Custom Value: *empty*	**IP Address:** 70.103.12.186
Response Started: Friday, April 2, 2010 12:39:27 PM	**Response Modified:** Friday, April 2, 2010 12:45:21 PM

1. Does your agency collect any type of customer data ? Please explain

We recently conducted a survey of our member agencies and other interested parties to assess how much importance they place upon our existing data products and potential new data products.

2. How often does your agency collect Customer Data?

On an as-needed basis (not very often).

3. Which Department(s) in your agency collects and/or uses this Customer Data? (if separate departments please identify)

Data Systems and Analysis

4. Does your agency use its Customer Data for any of the following? (check as many as apply)

Strategic Planning

Other (please specify) - Budgeting

5. Does your agency have formal (written) procedures for how to collect, distribute and use the Customer Data? Please explain if yes.

No

6. Does your agency collect specifically "Customer Satisfaction" Data? (Where Customer Satisfaction Data are user surveys that ask for ratings of satisfaction and/or performance of specific attributes, projects, or programs your agency is responsible for)

No

7. Does your agency collect any of the following ratings in your Customer Satisfaction efforts? (check as many as apply)

No Response

8. If further clarification is needed, who at your agency may I contact to follow-up this survey?

Carol Naito

Figure C.7 Survey Response (Chicago MPO)
***Responses collected by telephone**

Response Type: Normal Response	**Collector:** Customer Data Survey (Web Link)
Custom Value: *empty*	**IP Address:** 24.98.206.176
Response Started: Thursday, April 15, 2010 3:05:23 PM	**Response Modified:** Thursday, April 15, 2010 3:09:43 PM

1. Does your agency collect any type of customer data ? Please explain

Yes, Household travel surveys; at workshops and online forums

2. How often does your agency collect Customer Data?

for specific needs

3. Which Department(s) in your agency collects and/or uses this Customer Data? (if separate departments please identify)

Research and Analysis & Planning and Programming

4. Does your agency use its Customer Data for any of the following? (check as many as apply)

No Response

5. Does your agency have formal (written) procedures for how to collect, distribute and use the Customer Data? Please explain if yes.

Yes, Please explain - Use industry standards for question development etc, Internal procedures being developed.

6. Does your agency collect specifically "Customer Satisfaction" Data? (Where Customer Satisfaction Data are user surveys that ask for ratings of satisfaction and/or performance of specific attributes, projects, or programs your agency is responsible for)

Yes

7. Does your agency collect any of the following ratings in your Customer Satisfaction efforts? (check as many as apply)

Other (please specify) - general type; how satisfied are you with your travel choices, etc

8. If further clarification is needed, who at your agency may I contact to follow-up this survey?

Drew Williams Clark, CMAP

Figure C.8 Survey Response (Washington D.C. MPO)
***Responses collected by telephone**

Response Type: Manual Data Entry	**Collector:** Customer Data Survey (Web Link)
Custom Value: *empty*	**IP Address:** 24.98.206.176
Response Started: Thursday, April 15, 2010 3:12:25 PM	**Response Modified:** Thursday, April 15, 2010 3:14:23 PM

1. Does your agency collect any type of customer data ? Please explain

yes, household travel survey

2. How often does your agency collect Customer Data?

every ten years

3. Which Department(s) in your agency collects and/or uses this Customer Data? (if separate departments please identify)

Transportation Department

4. Does your agency use its Customer Data for any of the following? (check as many as apply)

Long-Term Planning

5. Does your agency have formal (written) procedures for how to collect, distribute and use the Customer Data? Please explain if yes.

Yes, Please explain - for data collection only

6. Does your agency collect specifically "Customer Satisfaction" Data? (Where Customer Satisfaction Data are user surveys that ask for ratings of satisfaction and/or performance of specific attributes, projects, or programs your agency is responsible for)

No

7. Does your agency collect any of the following ratings in your Customer Satisfaction efforts? (check as many as apply)

No Response

8. If further clarification is needed, who at your agency may I contact to follow-up this survey?

Bob Griffiths, TPB

APPENDIX D

Table D.1 Selected Attribute Measured Values

Clip #	Clip Distance (miles)	Street Name	HCM Class	LOS	Number of Through Lanes	Total Travel Time (seconds)	Space Mean Speed	# Stops (below 5 mph)	Total # of Signals
1	0.5	Rt 234	1	1	3	119	15.126	1	2
2	0.46	Gallows Road	3	6	2	48	34.5	0	3
6	0.43	Clarendon	3	3	2	87	18.28	1	2
7	0.48	Wilson Blvd	3	4	2	86	20.093	0	3
8	0.49	Wilson Blvd	3	2	2	130	13.569	2	5
10	0.53	Washington Blvd	3	3	1	113	16.885	2	3
12	0.47	Wilson Blvd	3	3	2	118	14.339	2	2
13	0.5	Washington Blvd	3	5	1	71	25.352	0	1
14	0.5	Glebe Road	2	1	3	161	11.18	3	3
15	0.5	Glebe Road	2	1	3	229	7.8603	3	3
20	0.55	Rt 50	1	2	2	122	16.23	1	2
21	0.5	Rt 50	1	2	2	89	20.225	2	3
29	0.5	Rt 234	2	4	3	79	22.785	1	3
51	0.44	M St	4	1	2	240	6.5	4	9
52	0.41	M St	4	2	2	186	7.9	3	7
53	0.6	Prosperity	2	3	2	121	18.46	1	2
54	0.6	Lee Hwy	2	4	2	93	24.5	2	4
55	0.45	Braddock Rd**	2	1	2	128	12.65	1	1
56	0.495	Sunset Hills Rd	2	4	2	77	23.13	1	1
57	0.61	Sunset Hills Rd	2	3	2	129	17.42	2	2
58	0.6	Sunrise Valley Rd	2	1	2	144	11.2	1	3
59	0.61	Sunset Hills Rd	2	1	2	182	12.06	3	2
60	0.5	Lee Hwy	2	2	2	120	15	1	3
61	0.7	Rt 50	1	4	3	91	27.69	1	3
62	0.5	Rt 50	1	5	3	49	36.73	0	2
63	0.5	Rt 50	1	6	2	53	41.86	0	2
64	0.5	Rt 50	1	2	2	92	19.56	1	3
65	0.5	Lee Hwy	2	6	2	50	36	0	3

APPENDIX E

Table E.1 correlation coefficients (ranked by clip)

C2-C15	C2-C52	C2-C56	C2-C21	C2-C55	C2-C60	C2-C53	C2-C54	C2-C57
-0.06315	**0.381748**	**0.339991**	**0.020606**	**0.22184**	**0.138898**	**0.449804**	**0.136082**	**0.011552**
C15-C52	C15-C56	C15-C21	C15-C55	C15-C60	C15-C53	C15-C54	C15-C57	
-0.00856	**-0.21184**	**0.829912**	**0.684618**	**0.335442**	**0.258679**	**0.34853**	**0.576875**	
C52-C56	C52-C21	C52-C55	C52-C60	C52-C53	C52-C54	C52-C57		
0.351124	**-0.03789**	**0.156444**	**0.204341**	**0.265965**	**0.294325**	**0.074929**		
C56-C21	C56-C55	C56-C60	C56-C53	C56-C54	C56-C57			
-0.11148	**-0.172**	**0.05883**	**0.53421**	**0.159475**	**-0.10341**			
C21-C55	C21-C60	C21-C53	C21-C54	C21-C57				
0.687568	**0.284164**	**0.27334**	**0.298836**	**0.6784**				
C55-C60	C55-C53	C55-C54	C55-C57					
0.155727	**0.197789**	**0.234499**	**0.428363**					
C60-C53	C60-C54	C60-57						
0.651565	**0.578024**	**0.212482**						
C53-C54	C53-C57							
0.366359	**0.066735**							
C54-C57								
0.23642								

Table E.2 correlation coefficients (ranked by respondent)

C2-C15	C2-C52	C2-C56	C2-C21	C2-C55	C2-C60	C2-C53	C2-C54	C2-C57
-0.60328	**-0.02271**	**0.384186**	**-0.31844**	**-0.3095**	**-0.04069**	**0.300342**	**-0.03151**	**-0.37482**
C15-C52	C15-C56	C15-C21	C15-C55	C15-C60	C15-C53	C15-C54	C15-C57	
-0.33174	**-0.59191**	**0.534323**	**0.496928**	**-0.20691**	**-0.35514**	**-0.26677**	**0.291307**	
C52-C56	C52-C21	C52-C55	C52-C60	C52-C53	C52-C54	C52-C57		
0.31212	**-0.48926**	**-0.21142**	**-0.00417**	**-0.11307**	**0.033568**	**-0.35074**		
C56-C21	C56-C55	C56-C60	C56-C53	C56-C54	C56-C57			
-0.43391	**-0.48285**	**-0.22093**	**0.231323**	**0.095085**	**-0.44331**			
C21-C55	C21-C60	C21-C53	C21-C54	C21-C57				
0.469875	**-0.37232**	**-0.48966**	**-0.37715**	**0.501049**				
C55-C60	C55-C53	C55-C54	C55-C57					
-0.42312	**-0.42589**	**-0.3128**	**0.062648**					
C60-C53	C60-C54	C60-57						
0.541755	**0.118177**	**-0.0684**						
C53-C54	C53-C57							
-0.05537	**-0.32851**							
C54-C57								
-0.17304								

APPENDIX F

Table F.1 Friedman Test Results (Region All)

Region ALL	Clip 2	Clip 15	Clip 52	Clip 56	All
counts (n)	139	139	139	139	556
sums	405.5	333.0	261.5	389.0	1389.0
means	2.92	2.40	1.88	2.80	2.5
k=4					
nk= 556					
$SS_{bg(R)}$	91.3				
X2(actual)	54.79				
X2(.95,3)	7.81	Reject Ho			

Table F.2 Friedman Test Results (Region 1)

Region 1	Clip 2	Clip 15	Clip 52	Clip 56	Clip 21	Clip 55	Clip 60	Clip 53	Clip 54	Clip 57	All
counts (n)	30	30	30	30	30	30	30	30	30	30	300
sums	136	106	80	153	147	103	107	178	159	75	1244
means	4.5	3.5	2.7	5.1	4.9	3.4	3.6	5.9	5.3	2.5	5.5
k=10											
nk= 300											
$SS_{bg(R)}$	1101.1										
X2(actual)	120.12										
X2(.95,9)	16.9	Reject Ho									

Table F.3 Friedman Test Results (Region 2)

Region 2	Clip 2	Clip 15	Clip 52	Clip 56	Clip 20	Clip 10	Clip 51	Clip 14	Clip 62	Clip 63	All
counts (n)	34	34	34	34	34	34	34	34	34	34	340
sums	181	112	83	207	190	144	51	124	166	156	1414
means	5.2	3.2	2.4	5.9	5.4	4.1	1.5	3.5	4.7	4.5	5.5
k=10											
nk= 340											
$SS_{bg(R)}$	1408.3										
X2(actual)	153.63										
X2(.95,9)	16.9	Reject Ho									

Table F.4 Friedman Test Results (Region 3)

Region 3	Clip 2	Clip 15	Clip 52	Clip 56	Clip 12	Clip 8	Clip 65	Clip 59	Clip 29	Clip 6	All
counts (n)	36	36	36	36	36	36	36	36	36	36	360
sums	193	123	116	213	146	148	165	81	91	142	1418
means	5.4	3.4	3.2	5.9	4.1	4.1	4.6	2.3	2.5	3.9	5.5
k=10											
nk= 360											
$SS_{bg(R)}$	1310.2										
X2(actual)	142.93										
X2(.95,9)	16.9	Reject Ho									

Table F.5 Friedman Test Results (Region 4)

Region 4	Clip 2	Clip 15	Clip 52	Clip 56	Clip 7	Clip 13	Clip 58	Clip 1	Clip 61	Clip 64	All
counts (n)	38	38	38	38	38	38	38	38	38	38	380
sums	198	143	82	82	154	199	130	155	194	168	1505
means	5.2	3.8	2.2	2.2	4.1	5.2	3.4	4.1	5.1	4.4	5.5
k=10											
nk= 380											
$SS_{bg(R)}$	1340.1										
X2(actual)	146.19										
X2(.95,9)	16.9	Reject Ho									

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